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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY A. S. RUSSELL, M.C., D.Sc.

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Editorial Notes

LAST year there was something of a boom in spiritualism. The subject was always before us. In newspapers and magazines, in debating societies and in private conversation, it was discussed and argued about at great length. There is no doubt that the subject has taken grip of the popular mind to a greater extent than in past years. The war is the cause of this awakened interest, and for a reason too obvious to require description. Many who do not wish to believe in spiritualism are disturbed by the adherence to the cause of several men of high character and unquestioned ability, distinguished in their walks in life. Furthermore, there are reports of occurrences which, if they be reported truly, should leave no doubt in the mind of an impartial judge that there is a queer game going on in the universe, of which at present we have hardly more than a glimmering.

* * * * *

It is well to bear in mind, before going further, that most phenomena associated with spiritualism at the present time have nothing whatever to do with what, in our best moments, we imagine spiritualism to be. Most of the phenomena are undoubtedly due to tricks played by people called mediums on their circle under the very best conditions for deception, namely concealment or darkness. Surely, if anything real happened at a séance, there would be no need of curtains and screens, or occasion for screwing down the gas. Deception it is, and it has been going on for fifty or sixty years. If anyone is sufficiently interested in the subject to wish to know how these deceptions and frauds may be brought about, let him read a report of thirty years ago, the Report of the Seybert Commission on Spiritualism,[1] which has been reissued this year.

* * * * *

The Seybert Commission met in Philadelphia—the City of Brotherly Love—from 1884 to 1887. Its object was to find out what it could on the subject of the truth of spiritualism, and to come to some definite conclusion, if possible, on the matter. The funds which defrayed the commission's expenses came from a believer in spiritualism, who, illogically enough, chose to die before his commission set to work. The members of the commission were carefully chosen, so that an unbiassed judgment might be arrived at, and throughout they behaved generously and very courteously to the mediums whom they examined. They said to these people in effect: "You say that wonderful things happen at séances: that spirits write messages on slates, that you, through them, read messages inside of envelopes, that they send messages to earth by lights, by raps, and other means, that they show themselves in material form or on photographs, and so on. All right, go ahead, get busy, let all these things happen, but let us sit beside you next time, so that we too may see these strange things; or, better still, come down to our house, be our guests, and let us all share the fun and the excitement."

* * * * *

And what was the result? The result was in every case that the manifestations at the séances were found to be fraudulent, and due merely to a little elementary conjuring, and to tricks so crudely performed that conjuring is too good a name to describe them. Ghosts were produced by dressing up somebody as a conventional ghost. Mediums disclosed the contents of sealed letters by removing the seal, opening the letter, reading

[1] Published by Lippincott. 6*s.*

and replacing it, closing the letter and putting back the seal—doing it very quickly and cleverly, of course. Rapping on a table was found to be due to the medium, or rather to the medium's toes, which, when everybody in the circle took hands, were free to strike the underside of the table. The great stunt in the eighties was writing on slates. Two slates were fastened together by a hinge on one side and a screw on the other. Between them was placed a small piece of slate-pencil—for the spirit. At a séance the medium started his invocation and the spirit wrote. It was apparently a daily, almost an hourly occurrence. The commission found, however, that, in every case it examined, the results were brought about by legerdemain on the medium's part, almost puerile in its simplicity.

* * * * *

This kind of thing is still being practised and believed in at the present time, but new tricks have, of course, been added to the medium's repertoire. In particular the wireless telephone has been a brilliant addition to his stock-in-trade. It is such a very useful thing. You require a complete telephone and an accomplice (a lady is best), and with a little practice and without a system, you may equal the Zancigs as mind-readers, and do many of the spiritualistic tricks such as the disclosure of the contents of a box by one who has never been near it. The lady accomplice puts the receivers of the telephone over her ears, and covers these either by wearing her hair like Cleo de Merode, or by wearing a suitable head-dress. The audience does not know she has the receivers on, and as there are no telephone wires noticeable, there is no reason why it should. You, the base deceiver, get possession of the information which your accomplice does not and cannot know, but which, the audience has been promised, will be forthcoming from her. It comes forth from her in due course, and without a mistake. How? wonders the audience. You have merely to talk to her by wireless from an adjacent room. Your audience will say it is wonderful, uncanny. Somebody, no doubt, will suggest that you have a system. But you haven't. It is merely common sense and the latest kind of telephone.

* * * * *

The fact that a conjurer, by means of legerdemain and apparatus, can imitate the phenomena that occur at a séance does not disprove their genuineness. The manifestations of the medium may be due to entirely different agencies. A clever conjurer can produce a spirit out of his side or from a box, so may a charlatan at a séance; it does not follow that spirits made manifest at séances and elsewhere are not genuine. The same clever conjurer can produce a rabbit out of his trousers pocket or from a hat, yet we know from experience that this does not prove that other ways of bringing rabbits into being are fraudulent. Our judgment on spiritualistic phenomena must depend upon our total experience—at séances and elsewhere. If everything that happens at every séance of which we have experience can be explained away on materialistic lines, the presumption is that the phenomena which occur at other séances of the same class can be similarly accounted for.

* * * * *

The two things that strike one most on reading this book are the gullibility of human beings (including ourselves) and the untrustworthiness of witnesses. People think they see things which do not occur, and fail to notice much that does. There is a great deal of belief in third- and fourth-hand information, and belief in things because certain authorities (who may turn out not to be authorities) believe in them. An amusing example of this is given by the Seybert Commissioners. In the late seventies, four German professors of science and philosophy, men of eminence in their respective lines of scholarship, were reported to be perfectly convinced of the reality of the observed facts of spiritualism, and that they were not due to imposture or legerdemain. This report exerted quite an appreciable influence upon the public mind in America. In getting down to the facts, the Seybert Commission found that, at the time these investigations were carried out, the four professors were completely at the mercy of the mediums. One of them was very blind, the second was suffering from cataract, the third was decidedly of unsound mind, and the fourth was so advanced in age that he did not even recognise the disabilities of his colleagues!

* * * * *

We may conclude this short account by quoting, from the appendix of the report, an account of a séance attended by Dr. Knerr, the only member of the commission who is now alive:

"It was my good fortune to meet with an *unprofessional* medium, a young gentleman of reputed honour and veracity, to whom I was introduced by a friend who had known him from childhood, and vouched for his honesty. This young man's mediumistic abilities had begun to develop with the planchette, and had reached the stage in which a drum and sundry musical instruments were played behind a curtain where he sat entranced, with his hands tied, tightly bound together by a handkerchief or cord. These séances were continued with regularity on certain nights in the week, and were confined strictly to the family circle and to a few privileged friends. There was, therefore, no temptation to deceive for gain. I came into the circle as an observer, not as believer, but was impressed by the phenomena witnessed at the first séance, in which the medium was under Indian control. There

were strange sounds, guttural tones and whoops which really might have emanated from a wild son of the forest. A drum, an accordion, a zither, a mouth-organ, were all played upon. The drum-sticks kept time to music, rapped on the wall, appeared above the edge of the curtain several times, brightly illuminated as if dipped in electric light or some phosphorescent substance. As I have said, I was impressed, and might have ended in complete conversion, by manifestations from so trustworthy a source, and vouched for in such sincerity, had it not, in an unlucky moment, occurred to me to apply a little harmless test.

* * * * *

"The test consisted simply in putting a dab of printer's ink on one of the drum-sticks at the very last moment before the séance began. The result could not prove physically injurious to the medium, who had challenged investigation, nor to anyone in the circle. The result was startling. Being accorded the privilege of tying the medium's hands, I proceeded to do so with a stout cord, using a certain knot which I believe has never been known to slip or come undone. This accomplished, and while someone else fastened the medium securely to his chair, with his back to the instruments on the table, the ink, concealed in a pocket-handkerchief, was applied. In this position we left the medium, the lights were lowered and the music began. Soon were heard the deep breathings preceding the trance, then "the Indian" began to manifest, at first somewhat sullenly, as if not pleased with the conditions, some of the instruments sounded, and at last the drum-sticks commenced their tattoo. At the close of the séance, when the curtains were drawn and the lights turned up, the medium was found in his chair with his hands still tied, but great was the astonishment of everyone present at the marvellous condition of the medium's hands. How in the world printer's ink could have gotten smeared over them while under control of "Deerfoot the Indian" no one, not even the medium, could fathom.

"I believe there is an explanation for these or similar phenomena, but I must leave it to the ingenious and adroit expounders of spiritualist philosophy."

* * * * *

An account,[1] by Professor Patrick Geddes, of the life and work of Sir Jagadis C. Bose, a distinguished Indian scientist, has recently appeared. Patrick Geddes is, of course, the well-known sociologist, at present a professor in the University of Bombay. This biography is a competent piece of work, but something very much better than this is expected from Professor Geddes. It compares ill with two recent biographies of scientific men, that of Sir Victor Horsley by Mr. Paget, and that of Silvanus Thompson by his widow and daughter. A reason for this is possibly that the subject of the biography is still alive. Sir J. C. Bose was born in Eastern Bengal, and trained in physics at Cambridge. For many years he has been a distinguished investigator of physical and physiological problems, doing most of his work at the Presidency College, Calcutta, where for many years he was Professor of Physics. He is now the Director of the Bose Institute in the same city, and a man of sixty-two.

* * * * *

Bose has made himself famous by his work on plants. By means of an instrument invented by him, the magnetic crescograph, he has been able to demonstrate the growth and other movements of plants. Plants grow, as we all know, but a growth of a foot per year, if calculated out, amounts only to a fifty-thousandth of an inch per minute. So slow a growth as this is naturally invisible in nature. That it can be demonstrated directly comes as a surprise, even to those who are alive to the wonderful things that science is constantly claiming to do. The crescograph makes the movements of the plant visible by magnifying them from one million to ten million times. It can detect, and measure, a rate of growth of a hundred-thousandth of an inch per second. "Our mind cannot grasp magnification so stupendous. We can, however, obtain some concrete idea of it by finding what the speed of the proverbial snail becomes when magnified ten million times by the magnetic crescograph. For this enhanced speed there is no parallel even in modern gunnery. The fifteen-inch gun of the *Queen Elizabeth* throws out a shell with a muzzle velocity of 2,360 feet per second, or about eight million feet per hour; but the crescographic snail would move at a speed of 200 million feet per hour, or twenty-five times faster than the cannon shot. Let us turn to cosmic movements for a closer parallel. A point on the Equator whirls round at the rate of 1,037 miles per hour. But the crescographic snail may well look down on the sluggish earth; for, by the time the earth makes one revolution, the snail would have gone round nearly forty times."

* * * * *

We may quote further to illustrate how the crescograph may be used for demonstrating the growth of a plant before large audiences. A plant is connected up to the crescograph, and the growth of the plant is demonstrated by a spot of light from the crescograph rushing across a screen. "A stop-cock is turned on, admitting cooled water into the vessel containing the plant. The movement of the spot slows down and ultimately comes to a stop: the growth activity is now held in a state of arrest, a thermometer indicating the exact temperature-minimum. The plant-chamber becomes gradually warmed, and with the removal of lethargy, the growth-movement is renewed, gathering

[1] *The Life and Work of Sir Jagadis C. Bose* (Longmans, 16*s.* net).

increased speed. Another stop-cock turns on a depressing agent, and the growth becomes paralysed; but a dose of a stimulant instantly removes the depression. The life of the plant becomes subservient to the will of the experimenter; he can exalt or depress its activity; he may thus bring it near the point of death by application of poison, and when the plant is hovering in an unstable poise between life and death, resuscitate it by the timely application of an antidote. It all looks like magic!"

But it is only an achievement of science.

* * * * *

Very recently, some of Bose's work has been called in question, the movements recorded by his crescograph being ascribed to other causes. He was challenged to give a demonstration of his instrument before some experts in physiology and cognate sciences. He accepted, and the result was that the experts testified to the genuineness of his demonstration of the growth of plant-tissues. Sir Jagadis Bose is really a physicist, and not a physiologist, by training, and consequently has had a good deal of opposition to encounter from those physiologists who foolishly dislike people of other sciences "butting in" to their subject. Part of the opposition, happily a small part, is due to the fact that Sir Jagadis Bose is an Indian.

* * * * *

In the *Geographical Review* for January, a writer calls attention to South America as a promising field for the extension of cotton cultivation. At present, from Peru and Brazil, there is but a small output, only 140,000 acres being planted, but efforts are being made to increase production. In Brazil, the north-eastern coast alone is cultivated for commercial purposes, but there seems no reason, provided they can be satisfactorily irrigated, why the inland districts also should not be planted. Other parts of the continent which are considered suitable are Bolivia, Paraguay, and the plains of Northern Argentina, which together form an area greater than the cotton land in the United States. The writer considers that labour and transport difficulties are the chief to be overcome, and that in the future these areas of South America may compete successfully with the United States, and those other parts of the earth from which at present raw cotton comes.

* * * * *

The Advisory Committee on Civil Aviation has just issued its report to the Air Ministry. They point out how urgent it is that civilian firms be helped financially, so that a healthy aerial-transport industry be developed, and recommend that direct assistance be given, up to a sum of a quarter of a million pounds, to firms whose planes fly over approved routes. The routes approved are London to Paris, London to Brussels, and London to Scandinavia. To qualify for financial help, a firm should carry out a minimum number of successful flights in both directions, say forty-five days of flying in three months, each flight being completed within an agreed number of hours. The civilian firm can then go ahead with an easier mind than at present, developing its own ways of doing things, improving its machines, its engines, and so on, and discovering the most reliable aerial routes. Its work, separate in its way from that of the R.A.F., will lead to results which will be of the greatest importance to both. And there can be no question of the immense strength to the Air Force that a well-developed civilian aerial-transport service would be in men, material, and ideas, in a time of need.

* * * * *

Dr. F. W. Aston, of Cambridge, is continuing his brilliant work on the constitution of the elements, referred to in early numbers of this Journal.[1] It will be remembered he showed experimentally that in several cases an element whose atomic weight deviated from a whole number on the usual scale of reckoning is simply a mixture of two or more very similar elements, the atomic weights of which are represented by whole numbers. In other cases, he showed that elements were "perfectly pure," i.e. not a mixture.

He has now extended his results to Boron (atomic weight 10·1), which is a mixture of two bodies 10 and 11; to Silicon (atomic weight 28·3) which is a mixture of three bodies 28, 29, and 30; and to Bromine (atomic weight 79·92), which is a mixture of two, 79 and 81.

He finds fluorine, sulphur, phosphorus, and arsenic to be "perfectly pure." Dr. Aston has recently been appointed to a Fellowship at Trinity College, Cambridge.

* * * * *

Surgeon-General W. C. Gorgas, of the United States Medical Service, who died in London last month, was a benefactor of mankind. A solitary individual working in Bangalore and elsewhere, Sir Ronald Ross, found out how to fight malaria. Gorgas applied Ross's results first to Havana, and later to Panama. By exterminating mosquitoes, he eliminated malaria and yellow fever, and so made possible the completion of the Panama Canal. That was something done. Also the doing of it aroused the world to the fact that some of the greatest scourges of mankind can be destroyed if only the right men are encouraged to go ahead and find a cure. Gorgas himself was not a discoverer, a pioneer. He was a man of action—what an enthusiastic American might describe as "a real live-wire guy right on the job every time." He was quick to appreciate the importance of discoveries in preventive medicine, and there was neither weariness in his brow nor languor in his heart in applying them for the good of his fellow-man.

[1] DISCOVERY, February 1920, p. 45; April 1920, p. 100.

Psycho-Analysis

By William Brown, M.A., M.D. (Oxon), D.Sc. (Lond.)

Reader in Psychology in the University of London (King's College)

THE psycho-analytic movement dates roughly from 1893, when Breuer and Freud published their joint contribution on "The Psychical Mechanism of Hysteria" in the *Neurologisches Centralblatt.* In this and in their articles appearing two years later, under the heading "Studies in Hysteria," are summed up the doctrine of psycho-catharsis[1] for which Breuer was mainly responsible.

Charcot, Janet, and other members of the French School had regarded hysteria as a form of mental dissociation, but had been unable to explain it further.

Breuer and Freud discovered that hysterical symptoms sometimes disappeared when certain early emotionally-tinged memories were called up to the surface of the mind by means of hypnosis. An important factor in the cure seemed to be that these memories had to be lived over again in all their original emotional intensity.

The method was called the Cathartic Method, because it consisted essentially in purifying the mind by affording to the subject an outlet for his bottled-up emotion. In short, as Freud says, "The hysteric suffers from memories," painful memories of an emotional nature, which had not been adequately worked out at the time of their original occurrence. If these memories are again brought to the surface and worked off by what is called "abreaction," the hysterical symptoms disappear. Two types of hysteria were distinguished with reference to the cathartic process:

1. *Retention hysteria*, which we have briefly described.
2. *Defence hysteria*, where the earlier memories that are responsible for the symptoms seem to have been kept out of consciousness by some sort of active mental force, "a defence mechanism."

Freud discovered in several of his patients that strong urging was needed to bring the memories to the surface; and, arguing from this observed fact of mental resistance in the patients, he deduced the existence of a state of repression of the memories. With this conception of *repression* a change came over the theory, because it involved the assumption of definite groups of subconscious (or, better, unconscious) mental processes of a particular nature, and it is with this conception of repressed unconscious ideas that Freud breaks away from Breuer and develops his own general theory of the Unconscious.

Freud very soon came to the conclusion that the experiences undergoing repression were sexual in nature; indeed, that they were invariably so. In this view, also, Breuer was unable to follow him.

At first Freud held that the repressed memories were memories of real sexual occurrences in the early life of the patient. Later on, he discovered that many of these so-called sexual *traumata* were imaginations on the part of the patient. He therefore had to change his theory to harmonise with this, and so developed his characteristic sexual theory, according to which neurotic symptoms are due, not so much to buried memories of a sexual nature as to disturbances in the process of psycho-sexual development in the child's life, including the childish phantasies concerned with the sexual problem.

Freud found that he himself was not very successful at hypnosis (only succeeding in about 30 per cent. of his attempts), so he cast about for some other means, and he found that, if he simply urged his patients in the waking state to remember what they could, the memories gradually came back; especially if he let them speak at random, as things came into their minds, significant memories appeared from time to time.

This is the method of psycho-analysis (the overcoming of resistance by free association).

The method of psycho-analysis is, then, the method devised to overcome resistance to the re-entering into consciousness of these repressed memories. (Hypnosis, in doing so, is said to increase the resistance in other directions.) Freud regarded his method as one of *evading* rather than *overcoming* resistance. His first view, as we have seen, was that these memories were of a sexual nature, and corresponded to memories of actual sexual occurrences in the patient's early life. Later on he was obliged to revise that view, because he found the memories were often not those of actual occurrences, but of fancies, etc.

Gradually he came to hold a theory in which the sexual instinct is considered to be one of early origin and subject to possibilities of abnormal development.

There is a form of infantile sexuality consisting of sexual processes concerned with the feeling of pleasure produced by sucking, pleasure in connection with the excretions, as well as pleasure arising from the infliction of pain and the suffering of pain, pleasure in exhibition, etc.

Such tendencies as these sometimes appear unchanged, or even exaggerated, in adults, and are known to medical science as perversions. These partial processes undergo certain degrees of repression or transformation, especially between the ages of

[1] Literally "purifying the mind."

five and thirteen or fourteen, and what is left converges towards the production of the normal sexual instinct and life of the adult.

His theory of functional nervous diseases was, that it was the outcome and sign of maldevelopment of the sex-instinct. These partial processes had either been repressed too intensely, or their mutual relation had taken an abnormal course. Some had persisted when they should have been outgrown, etc.

The hysteric suffers from repression of perverted sexuality. If the repression had not occurred, the patient would have shown, not a normal, but a perverted sexual life. He is incapable of a normal sexual life, because the kind he would show would be out of harmony with his own character and his social environment. The patient realises that a seemingly insoluble mental conflict is going on inside him, but by psychoanalysis he is enabled to sublimate it—that is, to direct the impulse along other channels. This opens up a path along which solution of the conflict may take place, the impulse can find its fulfilment in another way. Energy is put at the disposal of the patient, and he directs it towards other ends.

We have, then, already moved far away from the conception of catharsis, and we find a change in the psychological dynamics involved. Whereas Breuer spoke of *emotion* as something that could be worked out, now Freud speaks of *libido*, something perhaps physical rather than mental, which can be shifted from one idea to another, and which, when dammed up, may produce either physical or mental symptoms.

If the repressed libido fails to find an outlet in physical symptoms—the paralyses, contractures, anæsthesias, etc., of so-called conversion hysteria—it appears in consciousness as an *anxiety state*. In other words, repressed emotion appears in consciousness as anxiety.

The nucleus of the Freudian Unconscious is constituted of the repressed tendencies and memories of early childhood, and later repressions enrich this Unconscious with memories of later life. Memories that are out of consciousness, but have undergone no repression, are called by Freud " preconscious." The resistance that stands in the way of the entry of the unconscious memories into consciousness is named the " censor." An important portion of the infantile unconscious is the group of tendencies and memories relating to the child's parents, its feelings of love towards the parent of the opposite sex, and feelings of hatred and jealousy towards the parent of the same sex. This whole system of emotionally-tinged memories is known as the " Œdipus complex," because it corresponds to the theme of Sophocles' tragedy *Œdipus Tyrannus*, in which Œdipus unwittingly kills his own father and marries his own mother.

Freud considers that the dreams of normal persons are similar in origin to the symptoms of persons suffering from psycho-neurosis. Under the physiological and psychological conditions of sleep, unconscious wishes come to dream-consciousness and obtain a disguised fulfilment. Analysis, by the method of free association, reveals the nature of these wishes, and gives the meaning or latent content of the dream—something very different from the manifest content, i.e. the dream as it is remembered by the dreamer.

Space does not permit us to go into the details of Freud's dream-theory, nor to do more than mention the processes of condensation, displacement, and dramatisation that disguise the true meaning of the dream from the dreamer himself. In a similar way, Freud undertakes to explain the unintentional slips of speech and writing of normal people, bungling actions, and momentary loss of memory for names, etc., ordinarily well known to the individual, as the effect of unconscious wishes breaking into the stream of ordinary conscious life.

At the present time Freud's theories are undergoing careful testing by unbiassed observers, out of which they are likely to emerge in a greatly modified form. In particular, the exclusively sexual origin of the psychoneuroses will probably have to be denied. On the other hand, the theory and practice of the earlier method of psycho-catharsis have been abundantly confirmed by work done on " shell shock " cases during the War, especially cases seen in the Field shortly after their breakdown. Many of these cases showed complete loss of memory for their terrifying experiences, and the recall of these memories, together with the emotion of fear that had originally accompanied them, often caused the immediate disappearance of their hysterical symptoms. The patients had not been able to react adequately to their terrifying experiences at the time, and repression had occurred. Other cases suffered from anxiety as a result of the repression, and benefited in like manner by cathartic treatment.

No reference has been made to the important factors of " repression " and " transference " in the Freudian system, nor to the modifications of theory introduced by Jung and Adler, but enough has perhaps been said to indicate the significance of the system for modern thought.

For further reading:

Vorlesungen zur Einführing in die Psychoanalyse. Von Prof. Dr. Sigm. Freud: Zweite Auflage. (H. Helber & Cie, Leipzig u. Wien, 1918.)

Psychoanalysis. A Brief Account of the Freudian Theory. By Barbara Low. (George Allen & Unwin, 1920, 5*s.* net.)

Recent Work on Heredity

By J. S. Huxley, M.A.

Fellow of New College, Oxford

(*Continued from the July No., p.* 203)

(4) The Inheritance of Sex

For long, the inheritance of sex was as much of a mystery as sex itself. Even if we took maleness and femaleness for granted, how was it that, in each generation, roughly equal numbers of males and females were produced? Though sex itself is still among the more mysterious problems of biology, sex-inheritance has been shown to have a basis that is almost startling in its simplicity. Putting the facts in terms of the idea set forth in our last article, the idea that unit-factors are arranged in a fixed order along the chromosomes, it appears that a sex-factor exists in a particular chromosome, and that, while two of these sex-chromosomes are present in one sex, only one is found in the other. This is the one exception to the rule that chromosomes are always present in similar pairs.

These exceptional chromosomes carrying the sex-factor are usually called the X-chromosomes. In most animals, including man and other mammals, the sex with the two X's is the female, while the male has only one X. In the male, however, the other member of the pair is present, but is not similar to the X in behaviour, and often not in shape or size. It is called the Y-chromosome. It appears to be a chromosome that has been rendered inactive so far as taking part in inheritance goes. This inactivity is often followed, as in the case of other rudimentary organs, like the hind-limbs of whales or our own appendix, by degeneration; for the Y-chromosome is often smaller than the X-chromosome, sometimes tiny, and in a few cases altogether absent.

Thus in mammals the difference between the sexes, so far as chromosomes go, is that the female is XX, the male XY. What happens when the reproductive cells are formed? We have seen that, with ordinary chromosomes, reduction occurs, the two members of a pair being separated. In the female, since two similar X's are present, one will be found in every ovum. But in the male, X must separate from Y, so that half the male cells will carry an X-chromosome, and half a Y-chromosome. When an X-bearing sperm fertilises an ovum, the resultant individual will have two X's, and will therefore be a female; while when a Y-bearing sperm effects fertilisation, the resultant will be XY, and therefore a male.

A diagram will make this clear (see below).

If we interpret this in terms of sex-factors, various lines of evidence show that the real difference between a male and a female is that the female possesses two sex-units, two doses of sex-factor, while the male has only one, the Y-chromosome being inactive.

So far as it goes, this statement of the facts is adequate enough, and explains how there comes to be, on the average, an equality of the sexes in most animals.

But a great many questions are left unanswered. For instance, the males and females of the majority of higher animals differ from each other not only in the primary sex-characters, maleness and femaleness, but also in a great many so-called secondary sexual characters—for instance, the antlers of male deer; the bright colour of many cock birds; the moustache and beard of man; the high voice and small hands and feet of woman; and the differences in instinct between the sexes. Are the factors for all these differences simply part of the sex-factors, or are they quite separate, but somehow controlled by the sex-factors? There is no doubt that the second alternative is the true one.

To start with, wherever careful investigation has been made, an individual of one sex can be shown to contain the factors both for the secondary sex-characters which it possesses, and also those for the secondary sex-characters of the opposite sex, but in a latent condition. For instance, if a hen Golden Pheasant is crossed with an ordinary cock pheasant, its male offspring will show, besides some male characters derived from their father, others typical of the male Golden Pheasant. These must have been present, though invisible, in the mother. Again, when the ovary of a bird is removed, at the next moult the operated hen will appear with the plumage of a cock. Most startling of all, Steinach, in Germany, showed that, if the reproductive organs are removed from a young male rat, and ovaries from a young female grafted into the abdomen in their place, the male grows up into a creature resembling the female in every particular, not merely in size and form, but also in instincts.

We must therefore suppose that the sex-factor acts like a switch; one dose of it, in mammals, turning on a set of conditions which permit of all the male characters developing, two doses turning on the conditions that allow femaleness and female characters to appear.

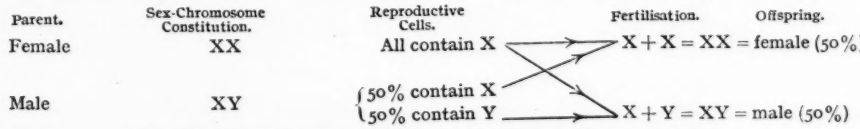

DIAGRAM OF SEX-DETERMINATION BY MEANS OF THE CHROMOSOMES.

Further, sometimes it may be possible to alter these conditions, so that some of the male characters begin to appear in a female, and vice versa.

We are all therefore double, as far as secondary sex-characters go ; but only one set is generally allowed to develop, while the other is kept latent. Sometimes, however, it is not kept completely latent ; and so come about the abnormal individuals with a mixture of the psychology of the two sexes, or even a reversal of sex-impulses. They are a problem to the psycho-analysts, and are often looked upon with great moral reprobation by ordinary people. But, in many cases, there can be no doubt that their condition is no fault of their own, but due to some slightly irregular working of part of the machinery of sex-determination. They are, in fact, what Metschnikoff called " disharmonies " in biology.

Finally, there remains the problem of controlling sex-determination experimentally. The problem is still very incompletely investigated. In frogs, there is no doubt that delay in fertilisation causes preponderance of males ; and in birds and moths, crosses between different varieties or species often result in individuals which ought, by their chromosomes, to be females, being transformed, sometimes incompletely and sometimes completely, into individuals of the other sex.

In general, we may say that it is becoming increasingly probable that, while the mechanism of the sex-chromosomes provides the usual basis for sex-determination, yet other influences may sometimes modify or override this mechanism, and that within the next few decades we shall probably be able to control, in some degree, the determination of sex in many species of animals, and possibly even in man.

(5) Heredity in Man ; and Research in Heredity

What grounds are there for believing that inheritance in man is based on the same arrangement of factors and chromosomes, and follows the same rules and laws, as in the lower animals ? The answer must be that inheritance in man is of the same description as in the rest of organised nature. The only essential differences between man and the lower animals lie in his brain and mental powers ; the rest of his physical basis is in every way similar to theirs, and we should expect it to have the same mode of inheritance. Further, although naturally we cannot conduct on man, generation after generation, the elaborate breeding experiments necessary to clear up the inheritance of a number of characters, yet some human traits have been shown to be transmitted in a Mendelian way. A type of malformation, known as brachydactyly, for instance, in which the fingers are abnormally stumpy, is inherited as a simple Mendelian dominant ; while hæmophilia, or the failure of the blood to clot properly, and some forms of colour-blindness, are inherited precisely in the way which we should expect for characters whose factors are lodged in sex-chromosomes.

But there remains the question, How far are mental qualities inherited, and if inherited, is their inheritance Mendelian ? To that it is as yet impossible to give a definite answer. The researches of Galton have shown us that many mental aptitudes are definitely inheritable, and if, as seems more and more certain, mental characters are associated with the physical characters of the cortex of the cerebral hemispheres, there is an immense weight of probability for the view that they are determined in heredity in the same way as any other characters of the organism.

Mendelian analysis, however, is another matter. Even with comparatively simple physical problems, this may bristle with difficulties. For instance, size in animals for many years evaded factorial explanation. Only recently has Punnett shown us that, in fowls at least, it appears to be due to Mendelian factors. The analysis of mental qualities is incomparably more difficult, partly because we cannot carry out definite breeding experiments, partly because of the inherent complexity of the characters involved, and partly because actual mental structure is so plastic and so largely determined by environment.

Since mental qualities are the dominant ones for humanity, it becomes clear that any legislation embodying what may be called positive eugenics is not, in the present state of our knowledge, practical politics.

By negative eugenics, however, we might even now accomplish much. There is a large body of evidence, for example, that a certain type of feeble-mindedness is inherited along Mendelian lines. If this is so, we can do a great deal towards diminishing the suffering and waste which it entails by preventing the reproduction of the feeble-minded, who, as a matter of fact, at the present time, have a very high birth-rate.

We have, however, reached a stage where eugenics can and should become a real science. Before Galton's time, it was the vision of isolated philosophers. During the last fifty years, it has won for itself a position as a political idea to be reckoned with. The recent development of genetical research has opened the way for a scientific study of human heredity. When this has been accomplished, we shall be ready for positive eugenics, content not merely to raise the average of society by cutting off the lower strata, but ambitious to heighten the maximum of human attainments, and definitely to assist the upward tendencies of evolution.

(6) Research in Genetics

We have at last, through Mendelism, a real science of animal and plant breeding—the science of genetics.

The new outlook which this has brought enables us to look at animals and plants in a new and illuminating way. A living animal is, above all, an individual, a single whole, with parts organically connected and working together. But from the standpoint of evolution, an individual animal is merely the guardian of the race, the beautiful and complex casket in which the reproductive cells are matured. As Samuel Butler put it, "a hen is the way one egg produces another egg." The view-point brought out by the study of inheritance combines both the others. The race is looked upon as in essentials a specific kind of living substance in which dwell a host of unit-factors. It is these unit-factors which determine the characters of the individuals. Not only this, but the unit-factors are capable of alterations, and these alterations may be permanent, giving rise to what we call mutations in the characters of the individual animals. From the standpoint of genetics, an animal is simply the product of the interaction of these unit-factors. In cattle, for instance, milk-production, colour, the possession of horns, size, shape, and many other characters are known to depend on such factors. When, therefore, we have proceeded far enough with breeding experiments on cattle to test the relations between the factors for these various characters, we shall be able to write out some sort of genetic formula for the different breeds of cattle. In the same way a chemist writes out formulæ for the structure and composition of his chemical compounds; and the real value of those formulæ in chemistry is that, by studying them, he is able to understand how these compounds will work—how they will react with various other compounds in one or another set of conditions. In the same way, a genetic formula—say of a breed of cattle—will not merely tell us that these animals have a particular arrangement of unit-factors: it will also tell us how those unit-factors will develop—that is to say, the characters of the individual cows of the breed; and also how they will interact with other sets of unit-factors—in other words, what we may expect in crossing the breed with another.

But work of this kind is very technical; the carrying out of it will demand, for all large animals, long periods of time, and the formulæ will be very complex. It is to be hoped that eventually the State will step in, and establish a National Genetical Laboratory on the same general basis as the National Physical Laboratory—as a place which will keep in touch on the one hand with the pure research being done in Universities and elsewhere, and on the other with the needs of agriculture and the community in general. Such an institution would, as a matter of fact, consist of a number of scattered stations, one concerned with the genetics of cows, others with those of wheat, or of pigs, or of potatoes. But the central organisation would be there, and would be the clearing-house for genetical work of importance in practical breeding, a register of all the known characters of all domestic animals and cultivated plants, and the recognised centre to which farmers could turn to ask for advice as to their breeds of stock and their strains of roots and cereals.

Experiments such as those of Professor Biffen at Cambridge on wheat, and of Pearl in America on fowls, show that the time is nearly ripe for such a scheme. What Government will earn fame for itself by daring to extend the Ministry of Public Health to include Eugenics, and that of Agriculture to include Genetical Research?

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The First Description of a Lake-village

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In 512 B.C. Darius, the greatest of the Persian kings, was free to turn his attention to the problems of his western frontier. His successful revolution against the impostor who for a time had usurped the throne of Persia, had been followed by the restoration of order in the large empire conquered by his predecessors. In the east he had carried their work to completion and the advance to Kashmir had established a satisfactory frontier. Above all, he had constructed an effective system of provincial administration which was to survive even the incompetence of his successors on the throne of the king of kings. In the west, however, work remained to be done. His western frontier, as it stood, was unsatisfactory, for the problems of nationality were as insistent in the days of Darius as in those of the Emperor Franz Joseph. Neither the Dardanelles nor the Aegean was an adequate barrier between his western subjects and their free kinsmen beyond his borders, whose example and sympathy alike incited the spirit of insubordination. These subjects could not be denationalised; the only alter-

native was to extend his frontiers to include their fellow-nationals, who were as yet free, and in consequence Darius embarked upon the "European policy" which was to lead to the Persian invasion of Greece. His so-called "Scythian expedition" in 512 B.C. probably achieved its object in making the Lower Danube his north-western frontier; and the fruits of this campaign were secured by the subsequent conquest of the Thracian sea-board by Megabazus, the most trusted of his generals.

Megabazus was on the whole successful in his mission. As a result of his campaign the northern coast of the Aegean was brought under Persian sovereignty and Macedonia within the Persian sphere of influence. A minor reverse, however, provided Herodotus with the excuse for inserting a brief ethnological digression which is of the very greatest interest to students of the early history of Europe. Some of the hill tribes, he tells us, successfully resisted the Persians. "They likewise who inhabited Lake Prasias" (the modern Lake Tachynos, familiar to those who have visited the Struma Front), "were not conquered by Megabazus. He sought indeed to subdue the dwellers upon the lake, but could not effect his purpose. Their manner of living is the following. Platforms supported upon tall piles stand in the middle of the lake which are approached from the land by a single narrow bridge. At the first the piles which bear up the platforms were fixed in their places by the whole body of citizens, but since that time the custom which has prevailed about fixing them is this. They are brought from a hill called Orbelus, and every man drives in three for each wife that he marries; and this is the way in which they live. Each has his own hut, wherein he dwells, upon one of the platforms, and each also a trap-door giving access to the lake beneath; and their wont is to tie their baby children by the foot with a string, to save them from rolling into the water. They feed their horses and their other beasts upon fish, which abound in the lake to such a degree that a man has only to open his trap-door and to let down a basket by a rope into the water and then to wait a very short time, when he draws it up quite full of them." [1]

When Rawlinson published the translation from which I have quoted, the pile-dwellings of the Swiss Lakes had been recently discovered [2]; but the full interest of the description given by Herodotus was not yet apparent. For archæological investigation has since revealed that buildings of this character are spread over a wide area from Hungary to Switzerland; and the remains of similar villages are to be found in the Italian Lakes.

Indeed the construction of pile-dwellings in lakes or marshes is one of the most important features of the end of the Stone Age in Central Europe; and the fishermen of Lake Tachynos, who under favouring natural conditions retained their original mode of living into the fifth century B.C.,[3] must belong to an offshoot of the same race as the Bronze-Age invaders of Northern Italy.

The earliest pile-dwellings on the Italian Lakes belong to the beginning of the Bronze Age, and it is probable in fact that their builders first brought the use of that metal into Italy. Whether these settlements were due to a single invasion from Switzerland or to two different streams of migration, one from the Swiss lakes and the other direct from the Danube valley, is a matter of dispute; but that their builders were an intrusive people belonging to the Central European stock is certain. They differ from the previous Neolithic inhabitants of Northern Italy alike in their funeral customs, their mode of dwellings, and their degree of civilisation. Their Stone-Age predecessors in Italy buried their dead. The contracted position of the skeleton at burial, secondary burial (i.e. the burial of the bones after the flesh has been artificially removed or allowed to decompose), the breaking of objects buried with the dead man for his use in the next world, and the use of red ochre for painting the skin of the living or the bones of the dead are characteristics which the Italians of the later Stone Age share with other branches of the Neolithic race of the Mediterranean area. Evidence for the earliest Italian lake dwellings is unfortunately lacking, but in the full Bronze Age it is certain that the lake-dwellers did not bury but cremated their dead. The body was burned and the ashes buried in the earth in an urn covered with a flat stone or an inverted basin. Bronze objects, often broken before deposition, have been found buried with the ashes.

Again, the previous inhabitants of Northern Italy lived, as indeed their descendants in the Ligurian hills continued to do in the days of Diodorus Siculus,[4] in caves or rock-shelters or in villages of curious circular huts. A circular or elliptical hole was dug in the ground, sometimes more than three feet in depth, and its sides were continued above ground by wicker-work covered with clay or skins. The lake-dwellers, on the other hand, lived in settlements like that described

[1] Herodotus, v. 16. Athenaeus, viii. 35, has also recorded the existence of a Thracian tribe which fed its live-stock upon fish. The name Mosynus, by which he describes the district, suggests, that he is thinking of the same or similar dwellers in pile-villages, for the word means "a wooden hut or tower."

[2] In 1854 the first of these lake-villages was discovered in the Lake of Zurich.

[3] Herodotus' history must have been published before 425 B.C., when Aristophanes parodied its opening chapters in the *Acharnians*.

[4] Diodorus, iv. 20, v. 39. Diodorus wrote his history in the reign of Augustus (31 B.C.–A.D. 14).

by Herodotus, and once more archæology has shown how accurate and trustworthy an observer was the much maligned Father of History. The form of these settlements differs, it will be noticed, from the *crannogs* of Ireland and Scotland, or the lake-village at Glastonbury. In the British Islands the lake-village was constructed upon a natural or artificial island, material being heaped up to form a foundation. The Italian lake-villages, however, consist of houses built upon rectangular platforms, which are erected upon piles driven into the bed of the lake. Their position is one of great strength for defence, as Megabazus evidently found, for they are cut off from the land by a narrow causeway sometimes of considerable length.[1]

The Neolithic people were pastoral. They lived by hunting or fishing and from the animals which they had domesticated, the ox, sheep, goat, horse, and ass. It is probable that they used the fruit of wild plants for food, but there is no evidence that they had arrived at the stage of agriculture. Remains of cultivated plants, however, have been found in the ruins of the lake-dwellings[2]; and the presence of spindle whorls shows that man was no longer dependent solely upon skins for his clothing. The use of metal, a true bronze, not copper, first appears in Italy with this people. One would expect further that lake-dwellers would develop some means of navigation, and in fact the remains of their canoes have been found. They are of a primitive kind, hollowed from the solid tree trunk and propelled by paddles. The essential differences between the mode of life of the lake-dwellers and those of the previous inhabitants of Italy make it certain that the lake-dwellers represent an intrusive people; while the similarity of the structure and contents of their villages built upon piles to those of the lake-dwellers of Central Europe shows us unmistakably whence they came.

Some time later in the Bronze Age than the early settlements on the Italian Lakes the basin of the Upper Danube became once more the centre of a movement of peoples who spread from their native valleys over Hungary, Bosnia, and Northern Italy. To this wave of invasion belong the later settlements on Lake Garda and the *terremare*. For the new-comers were akin to the previous invaders and, like them, were builders of pile-villages. So marked, in fact, is this characteristic of their existence that when they spread from the lakes to the dry land, they continued faithful to their old method of architecture. For the *terramara*,[3] as it is called, is the lake-village built upon dry land. Its form and orientation are uniform; though it may vary in size, in shape it is always a more or less regular quadrilateral (in fact, trapezoidal), and its eastern and western sides are roughly parallel and run north and south. It is surrounded by a moat and an embankment of earth supported on its inner side by a buttress constructed of wooden beams. The moat is fed by a channel from the nearest convenient running water. The channel discharges on to the acute corner of the embankment, which divides its waters to flow round each side of the moat, while the channel itself is curved just before its junction with the moat in order to lessen the force of the current and the strain upon the rampart. The water is carried off again by a trench about midway on the east side of the moat. Within the quadrilateral formed by the rampart and moat the area is divided by two main roads at right angles to each other running north and south and east and west respectively. The obvious similarity to the arrangement of a Roman camp goes even further, for the principal street is double the width of that which runs east and west. The entrance to the settlement was by a bridge over the moat at the southern end of the principal street. With the exception of the citadel, the interior of the quadrilateral was covered with houses built upon platforms exactly after the manner of the lake-villages, except that the piles rested not upon the bed of a lake, but upon dry land. In the centre of the eastern half of the quadrilateral and approached by the road which bisects it east and west is the citadel. This had sometimes a moat and rampart of its own, and was entered by a bridge in the centre of its western face. It consisted of a rectangular artificial mound of solid earth and contains no traces of pile structures upon it, but in its centre and on the line of the road of approach there is a trench with ritual pits similar to those found in some Roman camps.

The question has naturally been asked as to the reason for this peculiar mode of building; the answer is simply conservatism. It was at one time suggested that dread of inundation had led to the persistence of the type after the builders had left their original homes. The fact, however, that a moat of running water is a poor defence against flood suggested difficulties in this view, which has been finally disposed of by the discovery of *terremare* upon hilltops where the alleged reason cannot apply. On the other hand, their conservatism was not pushed so far as was at

[1] In the lake-village of Polada (Lake Garda), the double row of piles which supported the causeway connecting the settlement with the land is 100 yards in length.

[2] The evidence is not sufficiently trustworthy to make it certain that they were agriculturists before their invasion of Italy, but quite early in the Bronze Age they cultivated corn and millet.

[3] *Terramara* (plural *terremare*) is the label which has been adopted to denote a settlement of this type. Before the discovery of their real nature, the soil from the mounds, which were in fact the remains of these settlements, was extensively used by the Italian peasant for manure. This fertiliser he called *terra marna* or *terra mara*.

one time suggested by others; for the facts refute the theory that the quadrilateral within the rampart was flooded to form an artificial lake.[1] There is little doubt that the object of the moat and rampart was to provide defence, not against floods, but against human enemies; and that the houses within continued to be built upon piles simply because of ancestral fashion. The conservatism of this people indeed showed itself even to excess in the matter of sanitation. Upon the lake, the refuse of the house was naturally thrown overboard, and no doubt the ground-bait, which in this way descended through the trap-door, assisted in procuring the marvellous draughts of fishes which aroused the admiration of Herodotus. Apparently, when the village was transferred from the water to the land the housewives continued their old practices. Refuse was just dumped below the houses until the accumulation reached the top of the piles. When affairs reached this stage, drastic measures became necessary. The whole affair, refuse, platform, and houses, was set on fire and a new settlement re-erected upon the ashes of the old.

The *terramara* people burned their dead in open fires and buried the ashes in urns. Two characteristics, however, distinguish their burial customs from those of the earlier lake-dwellers. The burial of objects for use of the dead man in the next world is with them the exception rather than the rule. The second and most remarkable peculiarity is the close packing of the urns, which in a *terramara* cemetery are placed touching one another, and in some cases even in two layers one on top of the other. For obvious reasons the burials in the same layer cannot all have taken place simultaneously, and it follows that the urns can hardly have been buried deeper than to the neck or such close contiguity would have been impossible. The cemeteries were outside and at a little distance from the settlements of the living. In one case, at Castellazzo, the cemetery itself is in the form of a *terramara*. The ossuaries are not placed upon the earth, but upon a platform supported by piles and surrounded by a moat ten metres wide, which was crossed by a wooden bridge over its western side.

Although a *terramara* has been found even as far south as Taranto, the distribution of this civilisation is in the main confined to the country north of the Apennines. There is little doubt, however, that its authors moved south in the Iron Age and that the so-called " Villanova culture " is not that of a new race, but belongs to the *terramara* people in a new stage of their development. A branch of this people which passed into Central Italy became the ancestors of the Romans; and it is no mere accident that the general plan of the *terramara*-settlement presents so many analogies to the way in which the Roman camps were laid out.[2]

The account, therefore, of the lake-village which Herodotus gives, in itself interesting and curious, has for us a yet more curious interest than it had for the original narrator and his audience. For it is nothing more or less than the first and, I believe, the only first-hand description drawn from life of one of the lake-villages of the Central European type exactly similar to those in which the ancestors of the Romans must once have lived.[3]

[1] On p. 228 of Professor Myres's wonderful little book *The Dawn of History* will be found a sentence which I think implies this view. If so it is misleading; for there is no doubt about the facts as regards existing *terremare*. See Peet, *The Stone and Bronze Ages in Italy*, p. 338.

[2] " Old habits of life die hard, as we know; far beyond the Apennines, and in the age of iron, Roman armies fortified their nightly camps with a ditch and wooden palisade; their huts still ranged in four-square ' islands ' like the structure-lines of the old platforms; and the bridge over the Tiber which was kept by Horatius ' in the brave days of old ' was still a bridge of piles, in which no iron nail might be found, to be cut away in an hour on the near approach of an enemy." —Myres, *The Dawn of History*, pp. 228–9.

[3] The authoritative book in English is Peet, *The Stone and Bronze Ages in Italy*, which has the rare merit of an arrangement so orderly that while the archæological evidence is adequately described and examined, the reader who is not an archæological specialist is able to ascertain the conclusions and the author's reasons for reaching them without getting lost in a maze of specialist detail. Munro's *Lake Dwellings of Europe* is out of date; his latest views will be found in *Palaeolithic Man and Terramara Settlements in Europe* (1912). There is a brief but illuminating chapter on the Dawn of History in Italy in Professor Myres's *The Dawn of History* (Home University Series.)

British and Colonial Petroleum Resources

A Review of the Present Oil Situation

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NOWADAYS, when public attention is so easily attracted by any matter in the slightest degree sensational, or by one which promises to provide something out of the ordinary for popular diversion, it is not difficult to appreciate the cause of a certain liveliness in that particular section of the daily Press which exists solely for the purpose of supplying its readers with articles calculated to inspire the requisite feelings of satisfaction or apprehension. No matter what the subject under discussion, exaggeration and imagination are called into play in the production of the most misleading

paragraphs, and the resulting distortion of fact is only equalled in magnitude by the shameless extent to which scientific or economic principles are ignored.

Quite apart from the complexity of international politics (which surely provide food enough for the most insatiate literary appetite), since the Armistice we have had a succession of Press "scares," some with a foundation of fact, but most without any. The varied aspects of the present shortage of many of the necessary commodities of everyday life can be attributed, reasonably enough, to one of the more disagreeable legacies of the War; but the startling predictions of a world-famine in such vital essentials as wheat, coal, water, and oil—to cite only a few examples—require a somewhat closer scrutiny of their *bona fides* than the prophets of these disasters would be willing to admit. Articles of this kind, so long as they are confined to the requirements of advertisement or enhanced sales, are harmless enough, for the reader who allows himself to be influenced by their purpose assuredly deserves all he gets. It is only when they are written with the calculated intent of disturbing international relations that they assume a dangerous character; and in such circumstances, no amount of comment and censure should be spared which may proclaim or deny the validity of a particular case.

In the present oil situation we have a cogent example of Press propaganda of the very worst type, whose ulterior object is not so much the creation of an alleged oil famine scare, as the possibility of disturbing our political and economic relations with other countries; in particular the United States. It will have been apparent to those who follow carefully the happenings in the oil world, that the present agitation for a definite Imperial oil policy, to conserve our resources and relieve the tension of possible famine, is but a cloak to hide an attack on American tactics, rather than an honest attempt to review a situation which may or may not have arisen. Briefly, the arguments may be summarised as follows. On the one hand, we are told that the United States, knowing that we are very largely dependent on her for the bulk of our oil-supply, is adopting somewhat the attitude of a "profiteer" in making us pay extremely high prices for a commodity which she could easily afford to sell for less. Against this, we in turn are accused of adopting a "dog-in-the-manger" policy in other fields in which we are interested, especially in Persia and Mesopotamia, our aim being, it is alleged, the elimination of American capital and interest in future developments in those countries. And so as to bring the whole matter to the point of ebullition, the "experts" responsible for these indictments have dexterously juggled with statistics in order to demonstrate a universal decrease in oil output, an ever-increasing demand, and, in consequence, an ultimate famine in what has now become a vital asset to modern civilised life.

It is with the object of inquiring into the true state of affairs that these paragraphs have been written; and, without endeavouring to solve any of the recondite problems of British and foreign politics, it is proposed to present the reader with a survey of the position of our Imperial Oil Resources as it appeals to the petroleum technologist. This entails, among other things, an inquiry into the nature and extent of those resources and the possibilities of future development. If this be achieved, it can safely be left to individual intelligence to decide how far a political and economical impasse may or may not have been reached, and what precisely are the probabilities of an oil famine in the near or distant future.

In order to appreciate the first disturbing element in the matter, it is necessary to gain some idea of the present position of the oil resources of the United States. Writing in 1916 on this subject, Arnold, in the *Annual Report of the Smithsonian Institution*, adduced important statistical evidence showing that the total consumption of oil in the United States per year amounted approximately to 265,000,000 barrels. After surveying the possibilities of further development in the principal oilfields, he estimated the probable future supply at about 5,763,100,000 barrels, from which it is evident that in about twenty-two years from that date the United States production of oil would be exhausted. This is a somewhat pessimistic view to take of the situation, and it would seem that he has allowed the barest minimum of supply for unprospected areas in Texas, Wyoming, and other fields. If the bulk of the land to be prospected, not only in the Mid-continent but in the Gulf, Rocky Mountain, and other large fields, is only half as productive as that already proven in those fields, then his estimate of future supply falls short of the probable one by several thousand million barrels. This makes no allowance whatever for possible developments in such States as Alabama and Mississippi, which are regarded favourably in some quarters as potential oil-producers. But even admitting Arnold's figures, he himself states that the estimated supply would probably "spread over a period of from fifty to seventy-five years," mainly on account of the restricted use of petroleum as a fuel, and the gradual rise in price of a commodity of which the supply fails to satisfy the demand. Further, that before the supply of natural petroleum was exhausted, the Colorado, Utah, and Californian oil shales would be fully utilised, and artificial substitutes would largely take the place of petroleum as a fuel. From which it is seen that, while there is no need for immediate alarm in connection with the United States oil resources, there is every

need of some national scheme of conservation whereby the internal resources of the country may be utilised to the greatest possible efficiency.

The appreciation of these eventualities has led to a good deal of agitation for the introduction of a scheme of this nature, and the Press has, with its customary zeal, seized upon the opportunity to spread the news of famine in furtherance of its own particular propaganda. This, together with the unsettled state of international commerce, has been sufficient to create the feeling of tension in the oil world to which we have alluded.

Whatever the issue, it is obvious that to any policy which America may feel it necessary to adopt ultimately, having for its aim the preservation of her natural oil resources, no sane person can take exception. We have to realise that, like ourselves, America has received an enormous impetus to her motor and aeroplane industry as a direct consequence of the War, and the demand for oil fuel was never so great as at present. To meet this demand she has, perforce, to call on her own resources to a greater extent than before ; and consequently, if the limit of wise output be reached, her export trade is the first to suffer, with corresponding effect on those countries mostly dependent on her for their oil-supplies. This possibility constitutes the true danger of the position, and in foreseeing it, it is only reasonable that England should be prepared to meet such a contingency with a policy calculated to relieve any strain to which the British oil industry might suddenly be subjected.

It is common knowledge that we are largely dependent on United States oil for our requirements ; and in view of the fact that that country is responsible for nearly 70 per cent. of the world's supply of crude oil, and that we at present only control about 4 per cent., the possibility of the cutting down of American supplies is one to be guarded against. Fortunately, on this occasion at least, we are not content to await eventualities ; and although a definite Imperial oil policy has so far not been made manifest, a movement in one direction has resulted ; namely, the immediate development of our colonial oil resources. To these must be added our interests in Persia and our ultimate policy in Mesopotamia, concerning which our own Government has been consistently vague. In a contemplation of these possibilities, then, our petroleum experts have been and are being employed, and already some highly interesting data have been forthcoming. For our present purpose, it will help in the understanding of the position if we review the progress made in the past and the developments possible in the future, in the various productive areas within the Imperial Dominions. And for reasons quite apart from natural precedent, it is convenient to deal with the British Isles first.

In selecting our own country as an " oil-producing area," we at once take rather an anomalous step, since although, as mother-country, England must form the ultimate political and economic keystone binding our colonies into one united whole, as a crude oil-producing centre she is sadly insignificant, a statement which will doubtless meet with severe criticism from many quarters. It must be evident, however, even to the non-technical public, that the results of the recent boring operations in Derbyshire and elsewhere have not so far justified the flowery statements of confidence which characterised the scheme in the first stages of its initiation last year. " Hardstoft " is scarcely the great success which it was destined to be, a few tons of crude oil per day (according to the latest reports) being the usual rather meagre yield. Doubtless, with more powerful plant and greater pumping this yield could be raised somewhat, but even then the result could not possibly justify the outlay of capital necessary.

Little good could be served by reiterating the text of the several warnings uttered by expert geologists, both before and after the Derbyshire enterprise was commenced last year. In a very able article dealing with the geological reasons which render it unlikely that England will ever furnish a commercial supply of oil, Mr. V. C. Illing discussed this aspect of the question in the *Geological Magazine* of July 1919, to which the reader is accordingly referred. Writing just a year later, we have to admit that his admonitory predictions have not only been fully justified, but that the search for subterranean oil-pools not only in the Midlands, but in the whole of the British Isles, is a policy only dictated by those for whom scientific principles have little or no meaning.

" Hardstoft " and kindred propositions were defended by their supporters principally on the grounds that the requisite geological structures for the preservation of oil-pools were present in the areas, and the dangerous word " anticline " was flung hither and thither as an offset to the adverse criticism which the scheme met with from high scientific quarters. To the general public, and unfortunately to many so-called oil experts, the terms " oil " and " anticline " are almost synonymous, certainly inseparable. It does not follow, because subterranean anticlines can be proved in Carboniferous strata, that there, necessarily, oil will be located. It takes a man with an " eye for country," as the saying goes, to understand three-dimensional stratigraphy ; and, unfortunately, such men are the exception rather than the rule in the technical world. However, it is easy to be wise after the event, and one can only hope that this unnecessary waste of money, in conducting what is at most only an interesting experiment, will be speedily terminated ;

and, further, that it will be a lesson to those who anticipate similar schemes for other parts of the British Isles in the future.

We cannot leave the survey of English oil prospects without reference to the oil-shale industry, which is certainly rather a different proposition from that referred to above. It is a well-known fact that at certain horizons in the stratigraphical series, carbonaceous rocks occur from which, by artificial distillation, a form of petroleum may be obtained; but at present only one large field in this country has been worked for any length of time with success, and that is situate in the Midlothian Carboniferous field of Central Scotland. These shales have yielded over forty gallons of oil per ton in the past—though this is by no means a phenomenal amount for good oil shale—whilst the by-production of ammonium sulphate to the amount of 50 lb. and over per ton has been a contributing factor of no small importance to the success of these operations.

There seems to be no reason why the production of shale oil from this centre should not be a standard industry for many years to come, as the deposits are by no means exhausted. On the contrary, further extensions of the field should be possible within the confines of the main tectonic trough in which the Calciferous Sandstone series lie in this region. While, on account of certain complexities of structure, there may be an element of risk in putting down trial boreholes for the location of deeper seams, it would not be anything like so hazardous an undertaking as that to which the country gave almost tacit assent last year in Derbyshire.

Another field has come under the public eye of late, and one which promises to afford interesting results; namely, the Norfolk oil-shale field. Very little information has been forthcoming in connection with the development here, though the reader is referred to Dr. Forbes Leslie's paper, read before the Institute of Petroleum Technologists in January 1917, for general details. Geologically, this subterranean occurrence in Norfolk is of great interest, though in the present writer's opinion the structures are difficult of elucidation without adequate borehole data, and Dr. Forbes Leslie's explanations thereof do not always seem to him conclusive. Apart from that, it is certainly a possible field, and as such, a potential asset to our home oil industry.

Other occurrences of oil shale, such as those of Kimeridge in Dorset, the so-called "Kimeridge Coal," have been worked in the past with intermittent success. The Kimeridge shale yielded at times as much as 70 gallons of crude oil per ton, with a rather small amount of by-products. The extent of the shales, however, is extremely limited, and any mining of them would necessitate working thin and probably discontinuous seams over a wide area, a process which is seldom a profitable one.

For the rest, small oil-pools probably will be met with from time to time in various parts of the country during boring operations, particularly in Carboniferous formations; but the public would be well advised to receive such reports with the scepticism they deserve, and to realise once and for all that oil, in sufficient quantity to make it a commercial proposition, is certainly not one of the many blessings which Nature has seen fit to bestow upon us.

Crossing the Channel into the main continent of Eurasia, the oilfields can be divided into two main groups for present purposes: those in which we have financial interest, and those in which we have or may have both financial and administrative interests. With the former group we are not here concerned; it includes the important fields in Russia, Roumania, and Galicia, and so long as political and economic conditions allow, constitutes an open market from which we, in common with other countries, may draw large quantities of oil for home consumption. The other group includes our own colonies in Asia and the East Indies, and our interests in Persia and Mesopotamia.

In the countries of Burma and Assam occur probably the most valuable oil resources that we possess, the Upper Burma fields being already famous for their oil-production, while the Assam fields only await development on a large scale. The comparatively recent prominence of the Burma fields is largely due to the progress made in overcoming difficulties of transport, which formerly necessitated conveyance of the crude oil for over 300 miles via the Irrawaddy River to Rangoon. With the installation of pipelines, the production has naturally increased and further developments may confidently be expected, particularly in the Minbu and Yenangyat districts. The Assam fields have yet to be fully prospected, but no doubt exists as to the great possibilities of the Tertiary deposits of the Brahmaputra and Surma basins. The petroliferous beds are here often associated with coal seams, and are located along a belt of country stretching from Chittagong approximately N.N.E. for a distance of over 800 miles. At present the Digboi field, near Debrugarh, on the Brahmaputra, is the best-known region actually working; but the results of geological survey at various points along this belt have shown most favourable indications for the location of new sites, though in some places the structures are exceedingly complex, owing to the disturbed character of the strata.

Of the Malay Archipelago, British North Borneo, Brunei, Labuan Island, Sarawak, and British New Guinea (Papua), all show indications of oil to a greater

or lesser extent, though little is at present known of the commercial possibilities of the fields. North Borneo and Sarawak are perhaps the most important countries, and drilling is proceeding with a view to locating further supplies. In Papua, petroleum has been found along the same line of earth movement on which are situate the oil-bearing horizons of Java and Sumatra, and Dr. Wade has shown that the oil indications are extremely good, though conditions of climate and native labour have hitherto prevented prospecting on a large scale. Reported occurrences of oil in many parts of the Malay Peninsula have engaged the attention of geologists from time to time; but in the writer's opinion, the knowledge that we have of the geology of this region points to unfavourable conditions for the location of oil in quantity, although certain horizons in the restricted Tertiary formations may give a small yield from time to time.

The economic and political problems with which the future of the Persian and Mesopotamian oilfields is bound up still remain to be solved, and until conditions settle down from the present deplorable state of flux resulting from the War, it is a little premature to venture upon any suggestions as to developments of the petroleum resources of this part of Western Asia. Whatever our future policy with regard to these countries may or may not achieve, once the fields are better known and more widely prospected, the resulting influence on the world's supply of oil fuel will be far-reaching. Our knowledge of the Mesopotamian possibilities is largely based on reports and opinions gained during the War, and, geologically, on analogy of structure and conditions to those obtaining in the better-known Persian field to the east. Here the petroleum deposits lie along a belt of country extending from the Persian Gulf to some miles north of Baghdad, in a direction running parallel to the Turko-Persian frontier. The best-known field is that of Maidan-i-Naphthun on the River Karun. Other districts include Daliki, Zohab, and Loristan, all of which show great promise.

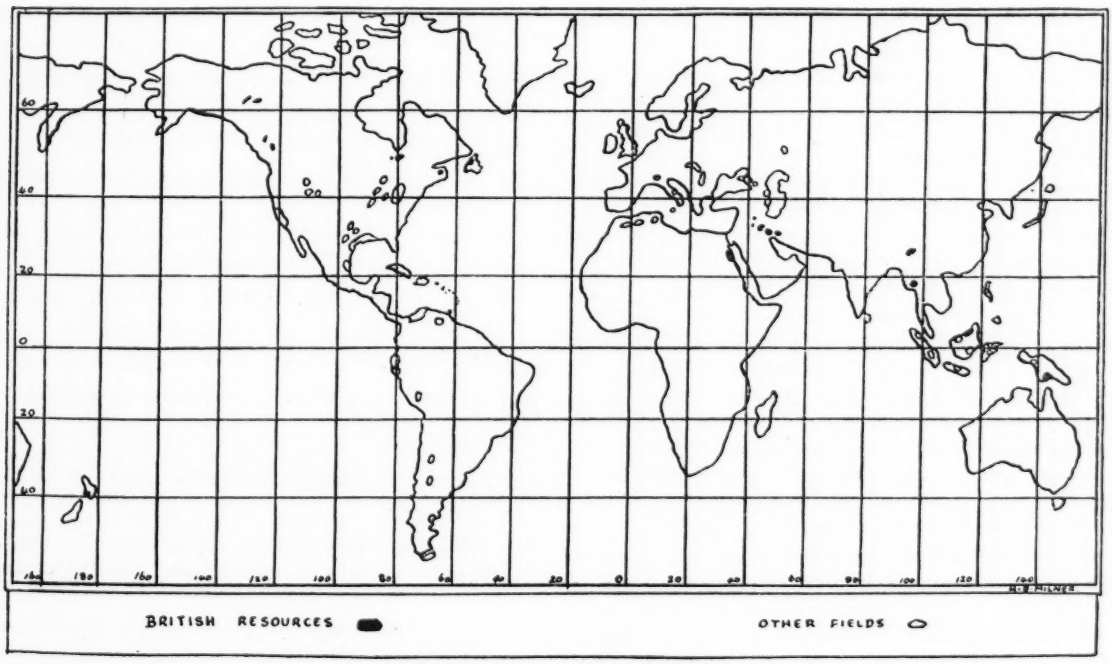
Passing now to the continent of Africa, our most important field is that of Egypt, where on the coast of the Gulf of Suez, at Jebel-Zeit and at Gemsah, a few miles to the south, operations are in active progress. The oil is chiefly found in the Miocene deposits, which are still undergoing energetic examination with a view to locating further pools. Latterly, the lower limestone horizons of the Miocene series have been the subject of detailed investigation, but so far no definite results have been forthcoming. Prospecting is also in progress to the east, in the Sinai Peninsula, where geological conditions are somewhat similar to those of the main Egyptian fields, while one or two islands in the Red Sea have been surveyed, but with negative results from a commercial standpoint. Other regions in Africa have from time to time been searched for oil, notably the Ivory Coast, Gold Coast, Nigeria, and Somaliland, but in all cases the results were extremely poor and unimportant. In Central Cape Colony there have been several petroleum indications in the past, connected with the carbonaceous Karroo shales, and owing their origin to the destructive distillation of those rocks as a consequence of igneous intrusion. In Northern Cape Colony similar occurrences are found in the Dwyka series, while carbonaceous shales, with occasional show of oil, are known from the Orange River Colony and in several other regions of South Africa. A great deal of prospecting has been done in these areas, but, as far as present knowledge goes, the geological conditions are entirely unfavourable to the preservation of oil, and it is unlikely that any important supplies will ever be obtained from this part of the world. There are still large areas in Africa unknown to us geographically, geologically, and economically; and though in mineral resources she is probably one of the richest countries in the world, the prospects of locating large oilfields are, from geotectonic considerations, essentially remote. Africa, like India, is a fragment of a "lost continent," in which we find no indications whatever of those great post-Carboniferous orogenic movements which have so fundamentally affected the continental mass of Eurasia; in it we are unable to trace the results of such tangential earth stresses as were responsible for the production of structures similar to those obtaining in the important Eurasian fields.

It is otherwise with the American continent, however, where in Canada, and particularly in the West Indies, our resources are considerable. Of the Eastern Canadian fields, in New Brunswick, Quebec, and Ontario, the latter is the most important oil-producing centre. Here the fields are located on what is known as the Cincinnati anticline, a fold extending northwards from Tennessee through Western Ohio to the Province of Ontario, and on which in the States some of the richest oilfields of Ohio and Indiana are situated. The most important fields in the Province are those of Petrolia and Oil Springs in Lambton County, where oil occurs in the Onondaga Limestone series of Devonian age. It is accompanied by large quantities of natural gas, of which the most productive is the Essex-Kent field. In New Brunswick a great deal of boring has been carried out for oil and gas which has only met with indifferent results, though the oil, when met with, has been found to be of a high grade. The fluctuations in output are largely due to the selection of poor sites for boring, and to lack of penetration to sufficient depth. The exploitation of oil in this province is an example of the dangers attending promiscuous boring

for petroleum without regard for anything more than doubtful surface indications. In Albert County, oil-shale deposits have been investigated which have yielded up to fifty gallons of oil per ton on distillation; these deposits have been surveyed in several areas within this region, with promising results. In Quebec, on the other hand, the results of exploration have proved unsatisfactory, both for oil and gas. One field (that of Gaspé) has yielded oil, but only in small amount, and the possibility of extensive supply is remote. The *Geological Survey* definitely advised against any further drilling within the province (1915), though this opinion has not met with general credence. In Nova Scotia, Prince Edward Island, and Newfoundland, bituminous shale deposits occur which have of late received attention; those of Nova Scotia are said to be as important as those of Scotland, and richer in hydrocarbon content. The Western Canadian fields embrace certain regions in the Yukon and North-west Territories, Alberta, Manitoba, Saskatchewan, and British Columbia, of which the Province of Alberta and the Mackenzie Territory seem to offer the best chances of future success. Prospecting in these areas has in the past been rather of a speculative nature, but with the increased data to hand furnished by the admirable work of the Canadian Geological Surveys, coupled with the experience already gained from some of the more promising ventures, future operations should meet with a considerable amount of success.

The oil potentialities of the West Indies have long been regarded as favourable, and of the five islands which have recently received attention in this respect, Trinidad and Barbados have both justified the initial work carried out. The Barbados petroleum deposits are much less important than those of Trinidad at the present juncture; they are mainly confined to the Scotland region of the island, where the oil is associated with Miocene sandstone and shale. The curious desiccated tar product "Manjak" occurs here, which has been mined considerably in the past. The Trinidad oilfields have been much more systematically developed than those of Barbados, and operations are proceeding on an ever-increasing scale. Petroleum indications are mostly confined to the southern part of the island, where the well-known fields of Tabaquite, Guaya-guayare, and Barrackpore, yielding very high-grade products, are located. A great deal of prospecting yet remains to be carried out before all the resources of this island are tapped, and, with the increased facilities of transport and the installation of further pipeline systems, rapid development may confidently be expected.

There remain for our consideration the countries of New Zealand and Australia. In New Zealand there are three principal districts from which oil seepages have been known, the most important being that of Moturoa, near New Plymouth, in North Island. From this source small quantities of oil have been obtained



PRINCIPAL OILFIELDS OF THE WORLD

intermittently, while the other two fields at Waitangi Hill and Kotuku are at present insignificant, and some doubt exists as to whether these localities will ever yield a commercial supply. The oil shales of the Orepuki region are generally known, but attempts to work them profitably have so far proved abortive. Borings near Greymouth, on the west coast of South Island, have met with little success, though the area between this and Brunnei inland will probably pay further prospecting. In Australia oil has been reported from many places on many occasions, but so far no results of commercial importance have been forthcoming. Dr. Wade has investigated certain supposed oil-bearing areas in South Australia, but concluded that the prospects were not encouraging. West Australia and Victoria have shown small oil seepages in several parts, but nothing has been discovered which would warrant extensive prospecting. In New South Wales, Queensland, and Tasmania, there are oil-shale deposits which have been worked on a large scale, and it must be admitted that the petroleum prospects of the continent, as a whole, seem to be largely centred in these occurrences.

This brings our brief survey of the British and Colonial oil resources to a close. From the accompanying map the distribution of the principal oilfields of the world can be noted, of which the British resources are shaded black. It is significant, at all events from a geophysical point of view, that our most productive fields (and, at the same time, those which offer the best possibilities of successful development in the future) are confined to the zone between latitudes 0° and 30° N.; and from what has already been said, it will be apparent that to the West Indies, India, and possibly the East Indies, we have to look for future resources. While we may not hope to discover fields of anything like the magnitude of those of the United States, there are at least equal chances that our own fields, and others as yet unknown, will yield to the prospector supplies of oil which, together with that obtainable from extraneous sources, would be sufficient to carry us through for many a long year. We must not forget that there are enormous possibilities of development in other parts of the world—such as Mexico, the Gulf States, South America (particularly on the north coast), Russia, and possibly Japan. The ultimate location of a productive field in any one of these regions would be quite sufficient to postpone a critical situation, if such were likely to arise. Each new well drilled, each new area surveyed, providing the essential principles of the science be kept in view throughout, brings the chance of further supply nearer. And each addition to the world's market must tend to alleviate any suggestion of famine that may be made. At present there is no oil famine, and in the writer's opinion there is not likely to be one for several generations. Every day, almost, a new wonder is proclaimed from the realms of experimental science, and synthetical productions are ever taking the place of natural resources. The question of substitutes for petroleum as a fuel is engaging the attention of experts all the world over, and if past success is any indication of the future, we cannot justifiably regard the prospects of their work other than with complete optimism. Economy in use of existing supplies, careful prospecting on scientific lines, greater development of the world's oil-shale deposits, and the use of substitutes for petroleum wherever possible, are arguments which collectively must tell in the long-run. We have not yet exhausted Nature's resources of coal, water, or oil; we may not see a generation's supply ahead, but that does not prevent us from continuing the search.

Books of the Month

The following is our monthly selection of books which we commend to the notice of our readers.

The Rescue. By JOSEPH CONRAD. (Dent, 9s.)

The latest Conrad. It is a wonderful romance of the South Seas.

Esther Waters. By GEORGE MOORE. (Heinemann, 7s. 6d.)

A reissue of a famous novel of the nineties.

From the Log of the Velsa. By ARNOLD BENNETT. (Chatto & Windus, 18s.)

An account of a holiday spent in a yacht along the coasts of Holland and Scandinavia before the war.

Follow the Little Pictures. By ALAN GRAHAM. (Blackwood, 7s. 6d.)

A first-rate mystery story.

Reputations. By DOUGLAS GOLDRING. (Chapman & Hall, 7s. 6d.)

Essays criticising the work of well-known contemporary novelists. Clever, independent, interesting, but rather too destructive.

My Life and Other Stories. By ANTON TCHEHOV. Translated by S. S. Koteliansky and Gilbert Cannan. (Daniel, 7s.)

The Men of the Nineties. By BERNARD MUDDIMAN. (Danielson, 6s.)

Anthropology and History. By PROFESSOR WM. MCDOUGALL. (Oxford Univ. Press, 2*s.*)

A lecture delivered to a scientific society in Oxford, showing the important bearing of the study of anthropology on that of history. Dr. McDougall has recently been appointed to the chair of Psychology at Harvard.

Discovery in Greek Lands. By F. H. MARSHALL. (Cambridge University Press, 8*s.* 6*d.*)

A short account of the principal excavations and discoveries of the last fifty years in Greece, Crete, Asia Minor, and Cyprus.

Report of the Seybert Commission on Spiritualism. (Lippincott, 6*s.*)

The Life of Benjamin Disraeli, Earl of Beaconsfield. Vols. v and vi. By G. E. BUCKLE. (John Murray, 18*s.* each.)

These volumes complete the great work, and cover the period 1868–1881. The principal contents for the reader not interested specially in politics are the voluminous correspondence with Queen Victoria, and the love-letters to Lady Bradford. An interesting psychological study. "There is no tale in Eastern or Western romance," says a reviewer, "to be compared, for successful adventure, with the Life of Benjamin Disraeli."

Space and Time in Contemporary Physics. By PROFESSOR M. SCHLICK. Rendered into English by Henry L. Brose. (Clarendon Press, 6*s.* 6*d.*)

Einstein's theory, and what it involves, dealt with in plain, non-mathematical language.

Abraham Lincoln as now Known to Us

By Lord Charnwood

(*Continued from July No., p.* 211)

THE preceding article has perhaps given indications enough that Lincoln was a firm and sagacious administrator in matters in which his contemporaries seemed to see vacillation and blundering. If we left out of account all larger questions of principle, and considered only how he dealt with the baffling problems of detail which confronted his Government day by day, he would remain a memorable figure in history, since the shrewdness which he displayed was that which is only possible to a man whose whole self is devoted to his task, and for whom petty considerations of vanity or anger or self-advancement have almost ceased to exist. The background of an originally ambitious career and of long practice in the minor arts of political combination from which these qualities emerged in his case enhances their greatness; and the incessant play of light humour in which this personal nobility manifested itself gives it unexampled charm. All this, though we can hardly pause to illustrate it here, meets the eye of anyone who casually turns the pages of a few of the numerous books about him. But all this, if it stood alone, would not suffice to rank him among the great historic exponents of principles of lasting moment. In showing that he does take rank among these, we have to face the fact that, as in lesser things he seemed at the time a blunderer, so in larger things he seemed to many to be without strong principle. His name is linked for ever with what may be called the decisive victory of the principle that all men have rights, yet he was not among the zealots who consecrated their lives to hastening that victory; he had taken no part whatever in the out-and-out "Abolitionist" agitation, and was even unsympathetic towards it. It is true that several courageous acts of his earlier career prove the sincerity of his hatred of slavery, but they were acts of no historic consequence; his only important action in the cause, before he became President and war was thrust upon him, was the negative action of protest against further extension of slavery. Thus he might easily be taken for an opportunist, though an opportunist with a conscience. He really belonged to a far less common type; he was a moderate man, whose moderation goes along with passionate conviction; a philosopher, with the power of cool and detached thought, and with vision reaching far and ranging wide, who yet retained the capacity of instant and decisive action when the rare opportunity came.

Negro slavery in America did not really present a simple issue which could be settled by saying, "This thing is wrong and must be stopped." In the first place, it was bound up with the question whether America could and should continue a single united country; and, in the second place, the legal relation of master and slave was but one element in the condition of the negro and in the whole social problem of the South. Now, Lincoln approached the conflicting requirements of perpetuating the Union, and not perpetuating slavery, with greater comprehension and decision than any other man, and possessed a sympathetic insight into the character and needs of the inferior race in which he stood almost alone among his contemporaries.

It would be granted by everyone that in every critical decision of general policy in these matters, from the moment when the Missouri Compromise [1] was repealed, Lincoln's course was happily guided. Up to the outbreak of war he avoided resolutely any further concession to the principle of slavery, and any provo-

[1] See DISCOVERY for July, p. 209.

cation to the South, though it was often a matter of delicate discernment to avoid both. In the earlier part of the war he held the North together by holding the balance between those who could fight only for the Union and the crusaders against slavery. He changed the character of the war from one merely for Union into one for emancipation also at precisely the right moment. Thereafter he was equally firm in refusing any compromise of the principles at stake through entangling negotiations with the South, and in discountenancing any spirit of revenge in the treatment of the reconquered States. Such a course might be said to coincide with the course of that sane public opinion which is apt eventually to prevail under popular government, but it would be absurd now to ascribe it, as a distinguished Illinois contemporary of Lincoln's, Senator Lyman Trumbull, ascribed it, to his being "a follower and not a leader in public affairs," "a trimmer, and such a trimmer as the world has never seen." To begin with, no man, not independently anxious for himself to see what is right and do it, has ever yet succeeded in conforming to the hidden movements of sane public opinion. But in Lincoln's case a close study of his life shows that his attitude was the result of principles thought out beforehand with rare thoroughness and consistency.

It is easy to glean and summarise those principles from his speeches, mainly made before his Presidency. They involved no moral lukewarmness about slavery; his hatred of it was none the less passionate because in practice he was restrained by regard for the Union. The Union of America was dear to him, because it represented the only great experiment so far made in popular government, a great country governed "till recently" by a "central idea," of "steady and progressive effort towards the practical equality of all men." It was compatible with loyalty to this "central idea," apart from which he could take no real pride in his country, that the strictest regard should be paid to the legal rights which, from the necessities of their case, the founders of the Constitution had conceded to the slave-owners of the South. But there was danger of going further than this, by allowing slavery to be lawful where it was not already protected by the Constitution, and by conceding in principle that slavery was in itself justifiable, or (even worse) that it was a matter of indifference. Such a policy was to be resisted at all costs, and at any risk to the Union and the existence of the country. If, on the other hand, slavery were placed in such a position that it could not be extended into fresh territory, and that the law and declared opinion of the Union as a whole marked it as wrong in itself, economic and moral causes would force the Southern States to abolish it for themselves in time. Till then any reckless attack on their constitutional rights would lead to the extinction in mere lawlessness of the American experiment in popular government. These beliefs, clearly set out in his earlier speeches on the subject, governed every important action of Lincoln's, from his first participation in the conflict in 1854 till the course of the war had altered the whole situation. Ultimately the blow which was to kill slavery, and which he seems vaguely to have dreamt of as a youth, became in his opinion, as a great lawyer, no breach of the Constitution, but a lawful and necessary act of war in defence of the Constitution. Thereupon he struck that blow. There can seldom have been in all history a statesman whose course was so well thought out on grounds of the profoundest political philosophy or so tenaciously pursued. We can repeat, in a very different sense from that which was first intended, the words of his sometime local rival, "Such a trimmer as the world has never seen."

But there is yet more to be said of that attitude of mind and heart which distinguished Lincoln equally from the ordinary Abolitionist and from the indifferent time-server. His principles were not only clearly worked out, they were envisaged by him in their true concrete application to individuals of flesh and blood.

Most men, who could have said with him, "if slavery is not wrong, nothing is wrong," and who could have exposed, like him, with bitter humour the half-sincere apologies for the system, would have been carried, at least when it came to war, into hatred of the Southern slave-owners. But to Lincoln the guilt of the system seemed not specially theirs; it attached in some sense to all their countrymen, even in a degree to himself. To him it was easy, while insisting with iron rigour on the complete conquest and unreserved submission of the South, to set his foot down on any kind of suggested vengeance, and to preach "we must extinguish our resentments" as the first principle of reconstruction after the war, a principle which far less resolute upholders of the war failed to grasp.

Most men, again, in fiercely contending against a wrong like slavery, would have nursed illusions as to the kind of equality with the white of which the black man was capable, and the benefits which would necessarily flow from liberation. It was not so with Lincoln. He was perfectly well aware of the frequent helplessness of the newly liberated people and the congenital weaknesses of the African. He foresaw the disruption of society and the suffering to black as well as white which war and emancipation would together produce in the South, and he laboured, though in vain, to prevent it. It is well known that he died before he could take any effective steps towards reconstruction in the South, but not before he had given outlines and hints of a policy by which the squalid agony of the years which followed would probably have been much lessened had

he lived. But it has been too little noted that, before the Proclamation of Emancipation became not only practicable but necessary, he had used every effort to initiate a policy of gradual and compensated emancipation coupled with education in the Border States, which was likely to have been spontaneously followed by each seceding State as it returned to the Union, and to have placed the negro in a better position than he occupies to-day. He failed because in his day he stood almost alone in what all would now recognise as a true view of the relation between the races. It was a kindlier, not a colder, view than that of any mere wholesale philanthropist. Few things are more moving in his Life than the notices preserved of his actual intercourse with negroes. It must suffice as an illustration that a great negro preacher who came to him, at his earnest desire, to confer with him on some acute point of difference, came away exclaiming in astonishment, "He treated me as a man! He did not let me feel for a moment that there was any difference in the colour of our skins!" How many of us ever produce that effect on a man of swarthier colour?

Thus the full comprehension, which was not at first possible, of Lincoln's main actions and motives produces an effect of intellectual and moral grandeur which his abundant minor failings only endear. If, further, we considered now the quality of his oratory, we should find it to lie, above all, in the sincerity of a man who would not "deceive the people even by a single adjective." His robust devotion to government by the popular vote was rooted in an intense but quite clear-sighted, patient, and disillusioned belief in the good that lies in ordinary people. Lastly, though the once hotly contested subject of his religion lies a little beyond the scope of this article, the truth, as it now stands out, lends a peculiar interest to the deepest of his wholly unorthodox and unconventional thoughts; and we may close our survey of his great work by recalling the words which he spoke, in a rare outburst of confidence, to a friend while his election to the Presidency was proceeding: "If He has a place and work for me, and I think He has, I believe I am ready."

The Discoveries in Crete

By George Glasgow, B.A.

(*Continued from June No., p.* 178)

III

If the nine Minoan periods into which Sir Arthur Evans has divided the Bronze Age in Crete are primarily a fanciful play upon the "nine seasons" of King Minos's reign in Knossos, the system of dating itself is by no means fanciful. It rests on a solid basis. It has been made possible mainly by the fact that the ancient Cretans were seafarers. Cretan products were exported to Egypt, and have been found there alongside Egyptian deposits of more or less known date. Hence a system of sequence-dating can be established. It is obvious that a Cretan vase found side by side with an Egyptian vase of 2500 B.C. belongs to an earlier period than one found with deposits of 1500 B.C. This fixing of landmarks is the first step. The second is to assign to them absolute dates in the terms of our own chronology. Owing to the fact that Egyptian dates (within at least certain limits) are known in terms of our own, and that Egyptian ware has been found in Crete as well as Cretan in Egypt, equation is possible. The chief difficulty is that Egyptian chronology is itself variously interpreted, and one particular version has had to be fixed on for comparison. Three convenient and easily-remembered landmarks have been established:

(*a*) Early Minoan II corresponds to Dynasty VI in the early Dynastic Period of Egypt, *circa* 2500 B.C.[1]

(*b*) Middle Minoan II corresponds to Dynasty XII in the Middle Kingdom of Egypt, *circa* 2000 B.C.

(*c*) Late Minoan II corresponds to Dynasty XVIII in the New Empire of Egypt, *circa* 1500 B.C.

Traces of commercial intercourse overseas can be found as far back as the Neolithic Age. Among the deposits of stone implements in Crete are great quantities of obsidian knives, and the only source of obsidian in the Ægean was the island of Melos. Obsidian is a kind of volcanic glass which flakes off into layers, giving a natural edge. Excavators, who are as childish as most people, have shaved with obsidian knives. It is said that the result has sometimes been a near shave.

It is probable that the Minoan Empire had a navy as well as a merchant marine. Minos was commonly represented as "Ruler of the Waves," and the Greek historians, Herodotus and Thucydides, refer to him as a mythical character celebrated as the first possessor of a fleet. The extent of the Minoan Empire can be gauged by the survival of many trading stations and naval outposts on all the shores of the Ægean, from Sicily in the East to Gaza in the West, which bore the name "Minoa." There was a discreditable chapter, so tradition relates, in the Empire's history. When the King's son Androgeos went to Athens to compete in the games, he carried all before him, and was slain in jealousy; whereupon the all-powerful Minos decreed that seven Athenian youths and seven maidens should

[1] As the evidence for this equation is slight compared with that for the other two, it must be accepted with reserve at present as a good working hypothesis.

be sent every nine years[1] to feed the Minotaur, a monster half man, half bull, which lived in the maze called the Labyrinth. The cruel tribute was paid twice; but on the third occasion, the hero Theseus volunteered to go as one of the victims; and with the aid of Ariadne, the King's daughter, who fell in love with him, he killed the monster. She gave him a sword and a supply of string, which he fastened to the entrance of the maze as he went inside. He was thus able to retrace his steps. Theseus had promised his father, the old King Ægeus, that if he returned alive his ship would show white sails in place of the usual black, so that the glad news could be read in the distance. Whether in his elation or in his hurry to leave Naxos, where (according to the story) he had deserted Ariadne,[2] Theseus forgot his promise, and Ægeus, watching anxiously from the cliffs, and seeing that the sails were black, threw himself in despair into the sea. It was thenceforth called the Ægean Sea.

Minos meanwhile reaped what he sowed. Dædalus, the architect of the Labyrinth, also incurred the King's wrath, and, making himself wings, fled to Sicily. His son Icarus, who went with him, flew too near to the sun; the wax which fastened his wings melted, and he fell into the sea. Minos pursued Dædalus to Sicily, and was treacherously killed. His countrymen went on a punitive expedition to the island, but never returned, and Crete was overrun by strangers.

That is legend. It is a fact, however, that the Minoan Empire did come to a sudden and violent end. Remnants of it—"the men from Keftiu" ("the Back of Beyond"), as the Egyptians called them—landed on the shores of Asia Minor, and finally settled in Palestine as the Philistines of the Bible. The mists of legend are clearing. The huge palace at Knossos is one of the solidest sights revealed. In its bewildering corridors, staircases, and rooms one recognises the Labyrinth itself—a recognition which is confirmed by evidence disclosed within the palace.

IV

The best description of the palace is to be found in Dr. Ronald Burrows's *The Discoveries in Crete*. A shorter description is given by Mr. and Mrs. C. H. Hawes in their admirable little book, *Crete the Forerunner of Greece*. It was built on the slope of a low hill overlooking a secluded valley, three and a half miles from the north shore of the island. While it escaped the notice of pirates, it commanded a view of the Minoan ships in the harbour.

Knossos relied for defence almost entirely on her fleet. In the report of his first year's work (1900), Sir Arthur Evans says[3] that, in contrast to the compact castles of the Argolid, "this Cretan palace, with its spacious courts and broad corridors, was designed mainly with an eye to comfort and luxury." There were minor fortifications, chiefly near the north gate, consisting of a guard-house and bastions, but strategic considerations did not contribute to the main architecture at all.

It is an amazing structure. Built as long before Christ as has the world travelled since, it sounds incredible that it should boast an underground drainage system and other "modern" contrivances. There is no doubt that Cretan architects were men of quality. Mr. H. R. Hall says, in *The Ancient History of the Near East* (p. 47), that, "in comparison with this wonderful building [the later palace at Knossos], the palaces of Egyptian Pharaohs were but elaborate hovels of painted mud. Knossos seems to be eloquent of the teeming life and energy of a young and beauty-loving people for the first time feeling its creative power." The present ruins belong to three structures built at different times. The first was built in M.M. I, or before 2000 B.C., and was burnt down towards the end of M.M. II. It was soon (*circa* 1800 B.C.) rebuilt on a bigger scale, and this building in its turn, some three hundred years later, was remodelled and enlarged. It is this last magnificent palace that predominates in to-day's ruins; in it the Cretans reached the height of their culture. This period, to which belongs what is known as the "Palace Style" in art, was as short-lived as it was brilliant. Within fifty years (so the evidence seems to show) the palace was raided and burnt, and that was the end of Ancient Crete; for the same invaders who sacked Knossos also destroyed the palace at Phæstos.

It is lucky, however, that Minoan libraries were made not of paper, but of clay tablets. They were preserved, not destroyed, by the fire. The baking they then underwent enabled them to survive the dampness of the soil, and they remain to this day, a potential interpreter of many things we do not understand—potential because they cannot yet be read. Scholarship has the hard but fascinating task before it of discovering from these documents the Minoan language. It is lucky, again, that the sackers of Knossos had no use for clay tablets, which accordingly escaped the doom of more "valuable" loot. Dr. Burrows, in *The Discoveries of Crete* (p. 19), quotes the happy analogy of a Reuter telegram which, in reference to the fire at Seville in 1906, announced that "the archives were totally destroyed, but the cash and valuables were saved!"

The outer walls of the palace were mainly built of gypsum, a stone composed of crystals of calcium

[1] Other versions say "every year."

[2] The discovery of the forlorn maiden by the god Bacchus is the subject of a famous picture, now in the National Gallery, by the great Flemish artist Rubens.

[3] *Journal of Hellenic Studies*, vol. xx, p. 168.

sulphate. It was so soft that it needed a covering of lime plaster to protect it against the weather. The palace was a square building covering about five acres, or as big an area as Buckingham Palace, and had a flat roof. In shape it was a hollow rectangle with a central court open to the sky. The west wing stood higher up the hillside and had fewer stories than the east wing, whose foundations sloped down to the valley. Beyond the west wing there was another court, and out to the north-west a smaller palace connected with the main building by what Sir Arthur Evans has called " the oldest paved road in Europe." At a point in this road stood the theatre, and there is nothing to prevent us from identifying it with the dancing-place (*choros*) which, so tradition tells us, " Dædalus wrought in broad Knossos for fair-haired Ariadne."[1] It would hold about 500 spectators, who made part or all of the " great throng that surrounded the lovely dancing-place, full of glee," if we may trust the same tradition. No doubt the boxing contests and other forms of sport were held there. The Cretans, to judge by the pictures which have been discovered, were given to strenuous and exciting, possibly cruel, forms of sport. A painted panel depicts a bull-fighting scene. There are two girls and a boy, the girls distinguished from the boy by their white skin, although all three wear the same sort of " cowboy " dress. A bull, head down, is charging one of the girls, who grips its horns in the attempt, apparently, to turn a somersault over its back, a feat which the boy is represented as in the process of accomplishing. He is halfway over, and the second girl stands ready to catch him.

V

The mass of buildings in the west wing of the palace (for plan of the palace see *Crete the Forerunner of Greece*, by C. H. and H. B. Hawes, p. 48) is divided into two by a long corridor running north and south, that in the east wing by one running east and west. In the west corridor, which is 4 yards wide and 66 yards long, there still stand some of the huge stone vases, " big enough," as Sir Arthur Evans has said, " to hide the Forty Thieves." They were used for the storage of grain, oil, wine, dried fruits, and the like. Under the floors were strong cists, or stone chests, some of them lined with lead, which probably would contain the State treasures. In a narrow corridor to the west of the south main entrance was found the fresco painting of the cup-bearer, an astonishing work of art. It represents a Minoan youth, of stiff but not unpleasing dignity, carrying a gold and silver vase before him. The fresco had fallen into the corridor, where it was found when the connecting wall broke down.

[1] Homer, *Iliad*, xviii. 590.

[*Continued on p. 250.*

THE

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The Throne Room of the palace is almost intact. The throne of Minos still stands, carved out of solid stone, and along the wall on either side are the stone benches on which his council sat. Minos was not only the legislative head of the State, he was also the Supreme Judge. So, at any rate, legend indicates, and experience proves that legend is a guide which can be trusted at least to indicate our path. Minos is represented by the legend as holding converse with Zeus every nine years in the Dictaean cave, and as receiving from him, after the manner of Moses in the Old Testament, a famous code of laws which held good throughout the period of the Minoan Empire. And at his death he carried on similar duties in the lower world. Odysseus, during his visit to the shades[1] "saw Minos, the famed son of Zeus, with his golden sceptre, dealing out justice to the dead, as he sat there."

The great staircase by which one descends into the east wing of the palace is surprisingly well preserved, and by 1910 the remains of five flights of it had been restored to their original positions. This staircase, in the words of its discoverer, was traversed "by kings and queens of Minos's stock, on their way from the scenes of their public and sacerdotal functions in the west wing of the palace, to the more private quarters of the royal household." These quarters were built on the south-east slope overlooking the valley of the river Kairatos. The Queen's *megaron*—a sort of hall with columns across it, open at one end to let in the light—was especially luxurious. Its wall paintings, designed in perspective, included a scene of the sea, with its playful fishes, and one of forest life. From the latter the picture of a gorgeously feathered bird has been preserved. The paintings further included a dado of dancing girls.

It is in this section of the palace that the drainage system is best exemplified. As it was lower than the rest of the building, and as the water-supply came from the west, the engineers were up against the problem of preventing flooding—a stiff enough problem for engineers of 4,000 years ago. They solved it by a system of pipes in parabolic curves which subjected the flow to friction. Sinks, lavatories, underground pipes—these are modern things. They nevertheless belonged also to the palace at Knossos. There were workmen's rooms and artists' rooms in the palace; every accommodation, in short, which was necessary for a complete community, for the palace was more or less self-sufficing, like a mediæval castle.

There was another great palace at Phæstos which stands at the opposite side of the island. It was smaller, but in many ways as magnificent, and was roughly based on the same plan of a system of wings grouped round a central court. Much speculation is invited as to what the relationship was between the two cities. The two palaces were built about the same time, possibly (in view of the likeness of style) by the same architects. Both palaces were destroyed more than once. Such are the facts, and the ice is thin for speculation. Were Knossos and Phæstos deadly enemies? The Haweses think[2] that the first palace of Knossos was "attacked and burned at the close of M.M. II, possibly by the rival ruler of Phæstos." Were they connected with each other? Mr. Hall[3] thinks that Phæstos was merely a southern residence of King Minos, who had unified the island under a *pax Minoa*. Legend relates that Phæstos was a colony of Knossos. An obviously significant fact to be remembered in any discussion on this point is that, in sharp contrast to the Mycenæan cities of the mainland, Knossos and Phæstos were in the main unfortified. It is true that M. Dussaud has suggested that Knossos was fortified, but the vast majority of scholars agree that his supposed "fortifications" were nothing of the kind. Dr. Burrows has devoted a special chapter to this point in the as yet unpublished second edition of his book, the manuscript of which he left in my care when he died. His general conclusion is that, while there may have been some sort of fortification in the early days of Crete, Knossos established a peaceful régime when she won her supremacy in L.M. I. In any case, Knossos was not fortified in the days of her empire. She had no fear from within the island, and s he had command of the seas.

VI

The buildings of the Stone Age have left hardly a trace of themselves, because they were made of such perishable materials as mud, reed, and wickerwork. Dr. L. Pernier has discovered, under the Minoan palace at Phæstos, a bit of the floor of one of these mud huts. It consists of red clay about 4 inches thick. Some houses, it is true, have been found near the modern Palaikastro, built of unhewn stone, and dating from the Neolithic Age, but they are exceptional. It was only when metal tools were invented that stone could be used generally for building. At the beginning of the Bronze Age the lower walls used to be made of stone, and the upper of sunburnt brick, the latter being further strengthened by wooden stays. Lime plaster was used even then to protect the walls against the weather. Later in the Bronze Age, when the great palaces were built, it became the practice to build foundations and lower walls to a height of about 2 yards of strong limestone blocks, some of them 3 yards long and 1 yard wide, and of gypsum. A protective covering of plaster was then applied.

[1] Homer, *Odyssey*, xi. 568.

[2] *Crete the Forerunner of Greece*, p. 70.

[3] *The Ancient History of the North-East*, p. 45.

The upper stories were generally of wood. Wood was extensively used. Professor Mosso,[1] in reference to a wall of the vestibule at the top of the great staircase at Phæstos, says that " a base of alabaster having been made, holes were made in it to fix slabs of wood all round. These were bound together, and the hollow was filled with a mixture of lime and rubble." Whole tree-trunks were sometimes used as beams, and one can still see the holes in the stone into which they were fixed.

There are many features of these palaces which are worth minute study. In the building of the great palaces it was the practice to prepare the ground with a thick mixture of lime and clay and pebbles. This mixture set so hard that it has now to be broken up with explosives before objects below can be removed. The staircase at Knossos measures nearly 15 yards from side to side, and the steps are 2½ feet wide and hardly 5 inches deep. The most famous steps in Rome were not more than 5½ yards from side to side. The doors of the palace, of which there were many, were made to fit into the walls when open, so as not to interfere with corridor space. At Hagia Triada the drains of 4,000 years ago may still be seen working in wet weather. At Knossos the main drain, which had its sides coated with cement, was more than 3 feet high and nearly 2 feet broad, large enough for a man to move along it ; and the smaller stone shafts that discharged into it are still in position. A little point of detail illustrative of the stage which Knossian architecture had reached is thus described by Dr. Burrows[2]: " Each of them was about 2½ feet long, with a diameter that was about 6 inches at the broad end, and narrowed to less than 4 inches at the mouth, where it fitted into the broad end of the next pipe. Jamming was carefully prevented by a stop-ridge that ran round the outside of each narrow end a few inches from the mouth, while the inside of the butt, or broader end, was provided with a raised collar that enabled it to bear the pressure of the next pipe's stop-ridge, and gave an extra hold for the cement that bound the two pipes together."

There were also baths at Knossos. At any rate, a good many people think they were baths. Professor Mosso thinks they were chapels—a good instance of the excitement which attaches to archæological research. There is no arrangement, says Professor Mosso, for the supply or discharge of water, a provision which many people will agree is necessary for a bath ; moreover, the basin is lined with gypsum, which is soluble in water ; one of them was placed in the Throne Room ; and, finally, they were not private. Professor Mosso's subtle eye even detects an enclosure,

[1] *The Palaces of Crete*, p. 47.
[2] Ibid., p. 9.

[*Continued on p. 252*

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which he maintains was not put there for the convenience of spectators of the bath, but for a chapel choir. These are attractive arguments, but Dr. Burrows answers quite simply that (1) the gypsum argument is ruled out because it would be covered with plaster; (2) terra-cotta tubs have been found close at hand, and the Knossians might quite well have been content with tubbing instead of plunging into a large tank that needed elaborate pipes; (3) the bath in the Throne Room was used for ceremonial ablutions, for which little water would be needed; and (4) no objects suggesting any cult (such as images or altars) have been found to show that these places were chapels. All this may serve to show what fine sport the archæologist may find in Knossos to-day.

Or take the lighting arrangements. There was a system of shafts used at Knossos, at Tyiissos (a little palace a few miles west of Knossos), at Phæstos, and at Hagia Triada. The light came down vertically at the back of the room, where the roof had been left uncovered for the purpose, and the floor specially cemented to stand exposure to the weather. Sir Arthur Evans enthusiastically declares that "the light pours in between the columns," and that "in cooler tones it steals into the little bathroom behind" —but on the latter statement Dr. Burrows remarks that it is merely a poetic way of saying that it is very dark there! Dr. Burrows, in fact, connects this darkness with the large number of lamps that have been found. Big marble-standard lamps have also been found which probably held two or even four wicks.

The use of lime plaster on the outer walls gave an opportunity to the Minoan artists, who not only executed fresco paintings thereon, but further fashioned the plaster into relief.[1] "Fresco" paintings are executed as soon as the initial setting of the plaster takes place, and while it is still wet. Brilliant colours were used—red ochre in the E.M. period (made by burning yellow clay), then yellow (from the natural clay) and black; then blue, progressing from a pale greenish tint in M.M. to a dark blue in L.M. The cup-bearer is an example of fresco painting, and the bull's head of high relief; the fresco painters merely attempted an outline and wash of colour in two dimensions, not indicating shades or folds of drapery. The main difference between Cretan painting on wet plaster and Egyptian painting on fine white limestone is that the Cretan gives a more vivid impression of movement, and the Egyptian more detail.[2]

There are many other sites in Crete which cannot be dealt with here—Gournia on the north coast, Palaikastro and others in the east, and Vrokastro. Their main importance lies in their bearing upon Minoan town-planning. Vrokastro has been explored by Miss E. H. Hall, who published her results in 1914.[1] It has a special interest because it belongs to the Iron Age, and shows the inferiority of this age to its predecessor, the Bronze Age. In general the houses in these towns were huddled together with the object of leaving as much ground as possible free for agriculture. They are poor specimens of houses; small two-storied cottages with windows on each side of the door. An interesting point about these Iron Age houses is that they were built on rocky eminences or spurs of mountains—a significant sidelight on the fall of Knossos and the disappearance of her fleet.

(To be continued)

[1] See "Minoan Lime Plaster and Fresco Painting," by Mr. Noel Heaton, *Journal of the Royal Institute of British Architects*, vol. xviii, 1911, pp. 697–710.

[2] See "The Relations of Ægean with Egyptian Art," *Journal of Egyptian Archæology*, vol. i, pt. 3, July 1914, pp. 197–205.

[1] Anthropological Publications of the University of Pennsylvania (Philadelphia).

Sir William Ramsay, K.C.B., F.R.S.

OCTOBER 2, 1852—JULY 23, 1916

The Discoverer of the Rare Gases of the Atmosphere

UNLIKE Sir William Crookes, the subject of our short biography this month was, as he himself has said, predestined by heredity for a scientific career, as his father's people were dyers and his mother's medical men. Although at school he was on the classical side, he took but little interest in the ancient languages which it was his lot to learn, and spent most of his spare time in making experiments in chemistry. In 1871 he obtained his parents' permission to go to Germany to study, and at first intended to enter Bunsen's laboratory, but later decided on Tübingen, where Fittig was attracting students by his researches in Organic Chemistry. On his returning to this country, after obtaining his Ph.D., he went as assistant to the University in Glasgow, and at the early age of twenty-eight was appointed to the chair of Chemistry at University College, Bristol, in 1880. Here his work was associated with that of Dr. Sydney Young, the lecturer in Chemistry, with whom he published a number of researches in Physical Chemistry, having discovered his bent for this branch of the science.

In 1887 he became Professor of Chemistry at University College, Gower Street, an appointment which he held almost to the end of his life; and it was here his life's work was done, not only in research, but also as a great teacher.

Lord Rayleigh had been at work for many years on the exact determination of the densities of the principal gases, and he had encountered certain difficulties which he was unable to explain. The density of nitrogen obtained from the air was not the same as that from ammonia. In 1892 he wrote to *Nature*, asking for suggestions as to the possible cause of this discrepancy. Two years later it was shown that it must be due to some unknown gas in the atmosphere with a density greater than that of nitrogen. On April 23, 1894, we find Ramsay writing to his wife a letter containing the following passage[1]:

"By the way, curiously, I am at work on nitrogen, but not from a commercial point of view; or, rather, Williams is. Nitrogen of air is heavier than nitrogen from ammonia in the ratio of 251 to 250. . . . Now, no one has ever taken all the nitrogen out of the air; or, rather, after all the oxygen has been removed from the air, no one has combined all the nitrogen. It is quite possible that there is some inert gas in nitrogen which has escaped notice. So Williams is at it now combining the nitrogen of the air with magnesium, and seeing if there is anything over—anything not nitrogen. We may discover a new element."

Less than a year later, on January 31, 1895, Ramsay and Rayleigh read a communication to the Royal Society announcing the discovery of this new gas, which they called Argon, and which was so inactive that they could not make it combine with any other element, do what they would. The next day Ramsay was reminded of the work of Hillebrand, who had found gases hidden away in the mineral Cléveite which he had believed to be nitrogen, and which it was now hoped might prove to be a compound of argon with some other element. So Ramsay set to work again to get these gases out of the minerals containing them, with a view to their examination.

On March 24, another letter to his wife tells of the second discovery[2]:

"Let's take the biggest piece of news first. I bottled the new gas in a vacuum tube, and arranged so that I could see its spectrum and that of argon in the same spectroscope at the same time. There is argon in the gas; but there was a magnificent yellow line, brilliantly bright, not coincident with but very close to the sodium yellow line. I was puzzled, but began to smell a rat. I told Crookes, and on Saturday morning, when Harley, Shields, and I were looking at the spectrum in the dark-room, a telegram came from Crookes. He had sent a copy here, and I enclose that

[1] NOTE.—The reader is referred to Sir William Tilden's *Life of Ramsay*, published in 1918 by Macmillan and Co., Ltd., from which this letter is taken, as well as the two quotations [2] and [3].

Also to Ramsay's own account of his work on the Rare Gases, in his *The Gases of the Atmosphere* (Macmillan, 1915. 7*s.* 6*d.*)

[*Continued on p.* 254

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copy. You may wonder what it means. Helium is the name given to a line in the solar spectrum, known to belong to an element, but that element has hitherto been unknown on the earth. Krypton was what I called the gas I gave Crookes, knowing the spectrum to point to something new. 587·49 is the wave-length of the brilliant line. It is quite overwhelming, and beats argon."

In April 1898, as the result of much thought, Ramsay writes in the *Annales de Chimie et de Physique*[3]:

"I believe, therefore, that an element hitherto unknown should find a place between helium and argon. We have looked for this element in vain. However, we have not given up the search, and if we succeed, the discovery would throw much light on the nature of helium and argon."

A month later the search had been rewarded, for Ramsay with Travers had discovered Krypton ("hidden") in the least volatile portion of a large quantity of liquid air, and only fourteen days after this Neon ("new") was found by the investigators. To cut a long story short, the process was repeated with a still larger quantity of liquid air, with the result that a very small quantity of yet one gas more was discovered. This was named Xenon ("stranger"), and completed the series of gases in the atmosphere, which were all found to be inactive and to have molecules containing but one atom. The work of Rutherford on Radio-activity next attracted Ramsay's attention, and he determined to see whether he could not fix the atomic weight of the "emanation" from radium discovered by Rutherford and Soddy; that is, if it proved to be an element. This involved the manipulation of cubic millimetres of gas only, but in work of this kind Ramsay was a past-master. Soddy and he soon found that the emanation gave rise to Helium, and thus they established definitely the first known case of transmutation. Seven years later Ramsay and Whytlaw Gray actually determined the density of this emanation and showed that it was a true gas, which they called Niton ("shining"). Furthermore, it was shown to fit into the Periodic Table[1] at the end of the series of rare gases already discovered.

Ramsay was a great traveller, and it was his wont to try and learn enough of the languages of the countries he visited, either on pleasure or business, to enable him to converse with the people. Among the journeys he took, mention may be made of one to Stockholm to receive the Nobel Prize. He was, in point of fact, a very notable linguist, and was able to lecture with ease in three languages, and to conduct an international assembly in as many tongues, in itself no mean accomplishment.

E. CAHEN.

[1] DISCOVERY, Feb. 1920, p. 42.

Reviews of Books

Applied Eugenics. By P. POPENOE AND R. H. JOHNSON. (The Macmillan Company, 14*s.* net.)

This book gives an excellent account of Eugenics and the relation of this subject to the affairs of everyday life. Mr. Johnson is a professor in the University of Pittsburg; Mr. Popenoe is the editor of the *Journal of Heredity*, which is the organ of the American Genetic Association.

What is eugenics, and what are those people who talk about it trying to do? Eugenics concerns itself with the improvement of the human race. Eugenists wish society to encourage the bringing into being of superior persons, and to discourage that of inferiors. Expressed more fully, the problem of eugenics is to make such legal, social, and economic adjustments that (1) a larger proportion of superior people will have children than at present; (2) that the average number of children of each superior person will be greater than at present; (3) that the most inferior people will have no children; and, finally, that (4) other inferior people will have fewer children than now.

There is a good deal of misconception about the nature and methods of eugenics. Many people do not understand what it is about, nor do they want to. Some imagine it involves the removal of much personal liberty; lethal chambers loom on the horizon. Others oppose it for reasons which are discredited by our present knowledge of biology and sociology. A book like this, which frankly states the case of eugenics, and shows the bearing of the subject on many of the important issues of present-day life, should be widely read. It meets difficulties. It is out to help. The Great War has caused great damage to the sounder portion of those nations engaged in it, and the next generation will have a larger proportion of weaker members than it would have otherwise. Because of this calamity the question of eugenics can no longer be considered merely academic. Fear of racial decline has brought it to the fore. In fifty years from now it will be a very big and important subject.

The opening chapter leaves no doubt upon the mind of the reader of the authors' view upon the relative claims of heredity and environment in producing superior people. They show that changes in a man's surroundings have little influence in changing the nature he has inherited, and that such changes are not transmitted to his children.

The authors then go on to discuss differences among men, the inheritance of mental capacities, the laws of heredity and natural selection. The origin and growth of the Eugenics movement is next fully described, and the extraordinary difficult and delicate problem of restricting the birth of children of physically and mentally inferior persons; and the other problem of increasing the marriage of superiors are very clearly and ably dealt with.

The book is written throughout in a clear style. It is not the least bit too technical for the average reader. The illustrations are good and well chosen.